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USAAVLABS TECHNICAL REPORT 70-30

THE EXPLORATORY DEVELOPMENT OF THE THREE-DIMENSIONAL DYNAMIC ANTIRESONANT VIBRATION ISOLATOR FOR ROTARY-WING APPLICATION

By

Robert Jones

August 1970

U. S. ARMY AVIATION MATERIEL LABORATORIES
FORT EUSTIS, VIRGINIA

CONTRACT DAAJ02-69-C-0003

KAMAN AEROSPACE CORPORATION
BLOOMFIELD, CONNECTICUT

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Under prior contracts, the feasibility of the DAVI concept was established for one- and two-dimensional vibration isolation. This feasibility was demonstrated through analysis and controlled laboratory testing. More recently, a flight test evaluation was performed to further assess the potential of these isolators. Here the isolators were subjected to an actual helicopter's vibratory environment. Results indicated wide variances of isolation as compared to laboratory tests. These variances were attributed to pitching and rolling excitations associated with offset cg's together with the lack of isolation in all three orthogonal directions.

This contract was initiated to determine the feasibility of the three-dimensional DAVI through laboratory-controlled vibration testing. It was believed that the isolator could minimize the coupling modes of motion from the complex vibratory environment typical of helicopters. Laboratory testing consisted primarily of shake testing a platform isolated at each of its four corners. To simulate multidirectional excitations, as experienced in a helicopter, some of the test loadings consisted of simultaneous vertical, lateral, and longitudinal shears in addition to pitching and rolling moments. Results demonstrated that effective isolation was simultaneously obtained in each direction.

During these tests, it was found that the three orthogonal antiresonant frequencies of the 3-D DAVI are sensitive to inertia-bar orientation and inertial coupling (caused by cg offsets or possibly resonance or near resonance in pitch or roll of the isolated platform). The extent to which inertia-bar orientation could influence performance (isolation) of the platform was explored. A "least sensitive" orientation was selected for all subsequent tests. The 3-D DAVIs were designed to have the same antiresonance in each of the three orthogonal directions. Tests revealed that these antiresonances did differ slightly--within 3 to 5 percent of the design goal. This modest discrepancy was not sufficient to inhibit the isolator's performance. However, it does suggest an explanation as to why better isolation is attained in one translational direction as opposed to another: in all loading directions the frequency of excitation is the same (for helicopters, rotor blade passage frequency); but in one direction it may coincide with an antiresonance, resulting in excellent isolation, while in another direction it is slightly off resonance, causing a less dramatic degree of isolation.

In related work, the DAVI concept was shown to be analytically feasible for helicopter rotor isolation for a number of configurations ranging from the LOH to the HLH. A full-scale experimental demonstration of this feasibility using the 3-D DAVI is currently under way.

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THE EXPLORATORY DEVELOPMENT OF THE THREE-DIMENSIONAL DYNAMIC ANTIRESONANT VIBRATION ISOLATOR FOR ROTARY-WING APPLICATION

Kaman Report No. R-814

By

Robert Jones

Prepared By

Kaman Aerospace Corporation
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Fort Eustis, Virginia

ABSTRACT

This report contains the results of the experimental testing of the three-dimensional Dynamic Antiresonant Vibration Isolator (DAVI).

A preliminary three-dimensional DAVI model was tested on the contractor's "Zero-Friction" test rig. This test consisted of an isolation survey from 5 cps to 20 cps with the vibratory excitation applied independently in the three orthogonal axes. The results of the test showed that the three-dimensional DAVI model exhibited the characteristic DAVI transmissibility versus frequency curve along each of its principal axes.

An improved three-dimensional DAVI model was designed and four models were fabricated. These models were installed on a platform and tested for an isolated platform weight of 60 and 160 pounds and for four different directions of excitation. The results of these tests showed that excellent isolation was obtained at the tuned frequency of the DAVI for all four directions of excitation.

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INTRODUCTION

The research to date on vibration isolation, sponsored by the U. S. Army Aviation Materiel Laboratories, has shown the feasibility of the DAVI through analysis and laboratory model testing. This research[1,2] was done on the unidirectional and two-dimensional DAVI's which are restricted to given directions of isolation. The unidirectional DAVI can isolate in only one direction. The two-dimensional DAVI can isolate only in a plane that is perpendicular to the inertia bar, and therefore requires conventional isolation in the third direction.

Many structures have a complex vibratory environment that gives rise to coupling between modes of motion, such that isolation cannot be achieved with the unidirectional DAVI and requires complex analysis and design with the two-dimensional DAVI. This problem of coupling due to a complex vibratory environment can be reduced with a three-dimensional DAVI. The purpose of this research is to determine the feasibility of the three-dimensional DAVI through laboratory-controlled vibration testing.

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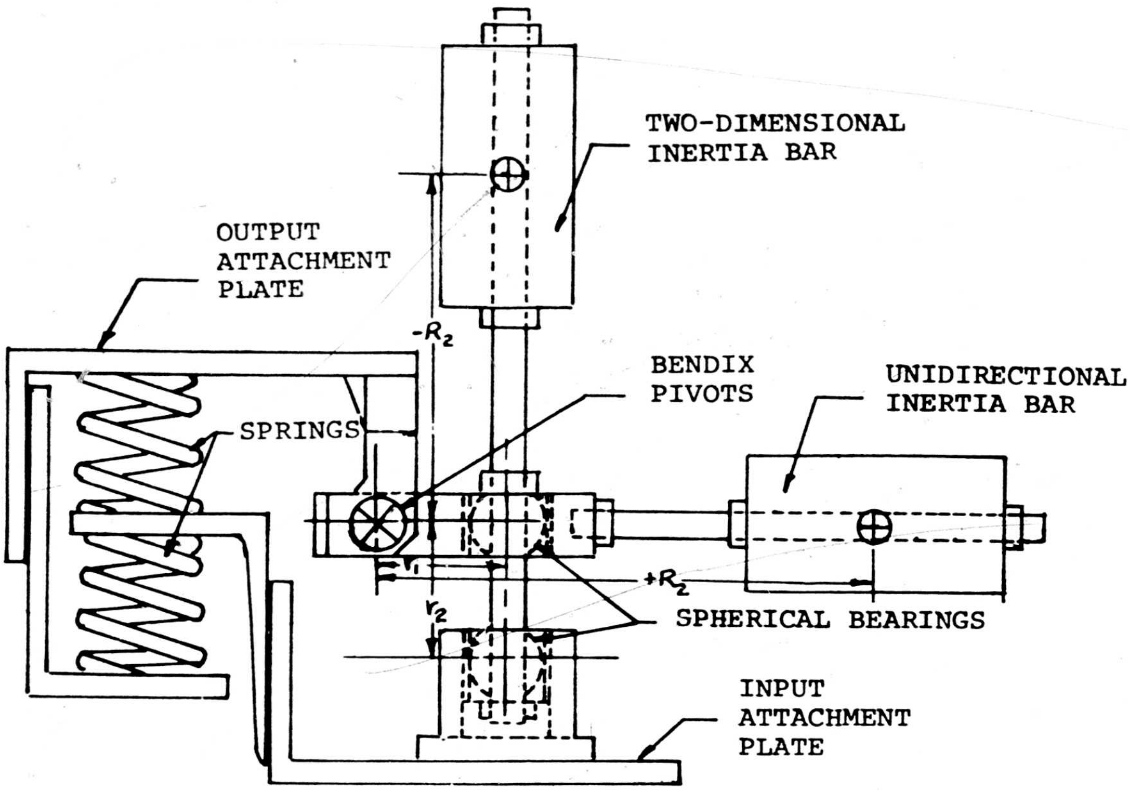
[1] Anderson, Roland C., and Smith, Michael F., A STUDY OF THE KAMAN DYNAMIC ANTIRESONANT VIBRATION ISOLATOR, Kaman Corporation; USAAVLABS Technical Report 65-75, U. S. Army Aviation Materiel Laboratories, Fort Eustis, Virginia, January 1966.

[2] Jones, Robert., AN ANALYTICAL AND MODEL TEST RESEARCH STUDY ON THE KAMAN DYNAMIC ANTIRESONANT VIBRATION ISOLATOR (DAVI), Kaman Corporation; USAAVLABS Technical Report 68-42, U. S. Army Aviation Materiel Laboratories, Fort Eustis, Virginia, November 1968.

PRELIMINARY THREE-DIMENSIONAL DAVI MODEL

DESIGN

Figure 1 shows a schematic of the preliminary three-dimensional DAVI model.



Note: (1) r and R are always measured from the isolated pivot.
(2) R is positive if in same direction from isolated pivot as r.
(3) R is negative if in opposite direction from isolated pivot as r.

Figure 1. Schematic of the Preliminary Three-Dimensional DAVI Model.

From the schematic, it is seen that the three-dimensional DAVI has two inertia bars. In this preliminary model, the two-dimensional inertia bar is connected to the base weight or input attachment plate and to the isolated weight or output attachment plate by spherical bearings. The unidirectional inertia bar which is at right angles to the two-dimensional inertia bar is connected to the isolated weight or output attachment plate by a hinge (Bendix pivots) which is a distance r_1 from the common spherical bearing connecting the two inertia bars. The hinge axis is perpendicular to both inertia bars.

As seen from the notation in the schematic, the unidirectional inertia bar has a positive value of R/r and the two-dimensional inertia bar has a negative value of R/r. The significance of this parameter is reported by Jones[1].

Vertical motion of the base weight or input attachment plate, that is, motion parallel to the helix axis of the springs, causes the two-dimensional inertia bar to translate with the base weight and also causes the unidirectional inertia bar to rotate about the hinge axis and the spherical bearing. Because the hinge has only one axis, the unidirectional inertia bar can rotate only in a plane perpendicular to the hinge, and therefore the unidirectional inertia bar tunes the vertical antiresonance only.

Horizontal translation of the base weight in either or both directions orthogonal to the vertical direction causes the two-dimensional inertia bar to rotate about its bearings. Therefore, the two-dimensional inertia bar tunes the horizontal antiresonance only. With horizontal translation of the base weight, the unidirectional bar does not translate and the weight of the unidirectional bar adds to the isolated weight.

In order that comparisons could be made with previous tests made on other DAVI configurations, the weight of the DAVI inertia bars and spring rates of the preliminary three-dimensional DAVI were made the same as those of the unidirectional DAVI tested and reported by Jones[1]. Table I gives the physical parameters and the anticipated performance of the preliminary three-dimensional DAVI model. The anticipated performance was obtained from the design charts for the unidirectional DAVI reported by Jones[1]. These design charts can be used to obtain the performance along each of the three

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[1]Jones, Robert., AN ANALYTICAL AND MODEL TEST RESEARCH STUDY ON THE KAMAN DYNAMIC ANTIRESONANT VIBRATION ISOLATOR (DAVI), Kaman Corporation; USAAVLABS Technical Report 68-42, U. S. Army Aviation Materiel Laboratories, Fort Eustis, Virginia, November 1968.

TABLE I. ANTICIPATED PERFORMANCE OF THE PRELIMINARY THREE-DIMENSIONAL DAVI MODEL

Principal Axis	Isolated Weight (lb)	DAVI Inertia Bar Weight (lb)	Spring Rate (lb/in.)	Effective R/r	Natural Frequency (cps)	Anti-resonant Frequency (cps)	Transmissibility at Very High Frequency $T_{\alpha VHF}$
Vertical	40	2.25	400	+4.5	6.9	9.0	.62
Lateral	40	2.25	400	-3.6	6.5	9.0	.50
Longitudinal	40	2.25	400	-3.6	6.5	9.0	.50

principal axes of the three-dimensional DAVI. These design charts are based upon the DAVI having a thin rod as an inertia bar. Therefore, for the preliminary three-dimensional DAVI model, only an effective R/r can be obtained.

TEST EQUIPMENT AND PROCEDURE

The main purpose of testing the preliminary three-dimensional DAVI model was to determine if the characteristic DAVI transmissibility versus frequency curve could be obtained independently along each of three principal axes of the three-dimensional DAVI model, and to visually determine if there was coupling or interaction of the inertia bars.

The preliminary three-dimensional model was installed on the contractor's "Zero-Friction" test rig. Figure 2 shows an overall view of the test setup. An electromagnetic shaker with a force capability of 50 pounds was connected to the base weight to provide the excitation. Two velocity pickups were attached to the input and isolated weight. The output of the pickups was fed to a vibration meter, and the results were manually recorded. The output velocity of the isolated weight was divided by the input velocity of the base to obtain the transmissibility.

A vibration survey from 5 cps to 20 cps was made along each of the principal axes of the model, and the transmissibility curves were obtained.

TEST RESULTS

Figure 3 shows the results of the test for vertical transmissibility - the direction of excitation was parallel to the helix axis of the springs. For vertical motion of the base, the two-dimensional inertia bar translates with the excited base but does not rotate about the pivots. Thus, only the unidirectional inertia bar is effective. Figure 4 gives the results of the test for longitudinal transmissibility - the direction of excitation was parallel to the longitudinal axis of the unidirectional inertia bar. Figure 5 shows the results of the test for lateral transmissibility - the direction of excitation was perpendicular to the axes of both inertia bars. For longitudinal and/or lateral motions of the base the vertically oriented two-dimensional inertia bar oscillates about the spherical pivots. The lower spherical bearing housing translates with the base, but the upper bearing housing to which the unidirectional inertia bar is attached does not move - the bearing merely pivots within the housing. Thus, for in-plane excitations only the two-dimensional inertia bar is effective and the unidirectional inertia bar is part of the isolated weight. Table II shows a comparison of the anticipated results and the test results of the preliminary three-dimensional DAVI model.

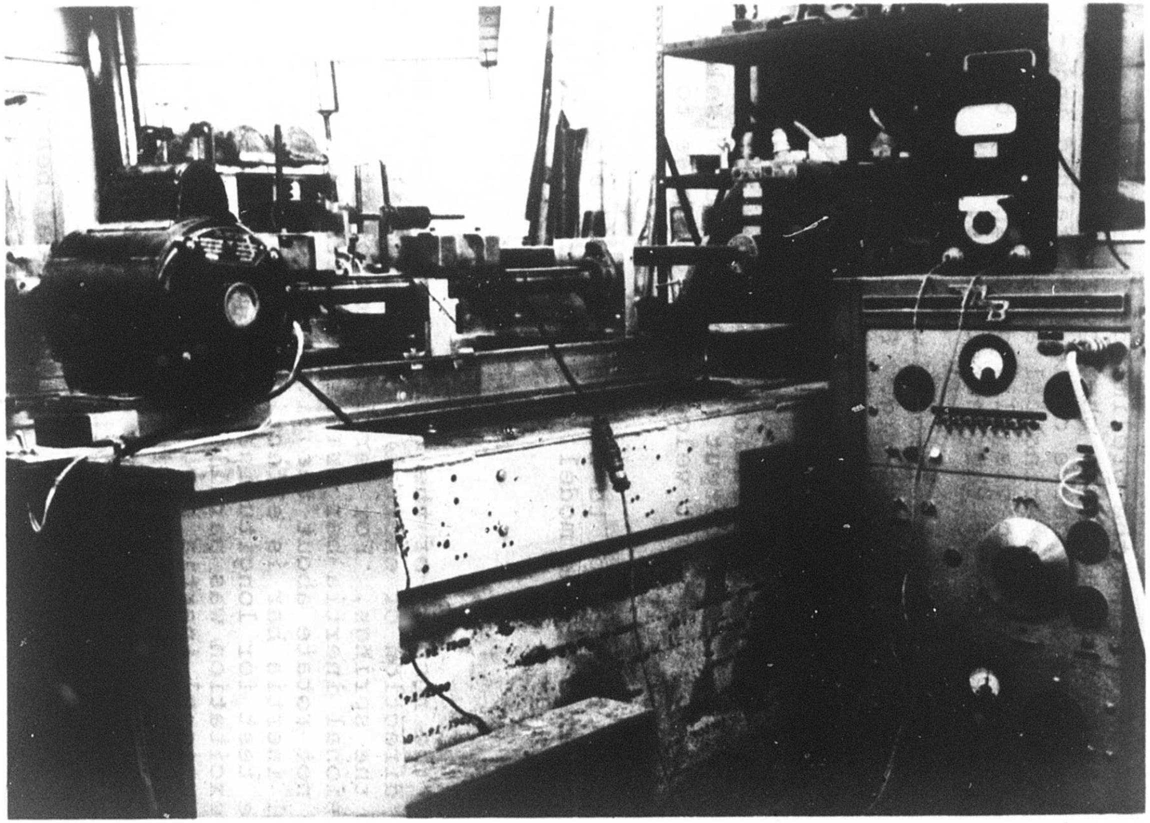


Figure 2. Preliminary Three-Dimensional DAVI Model Test Setup.

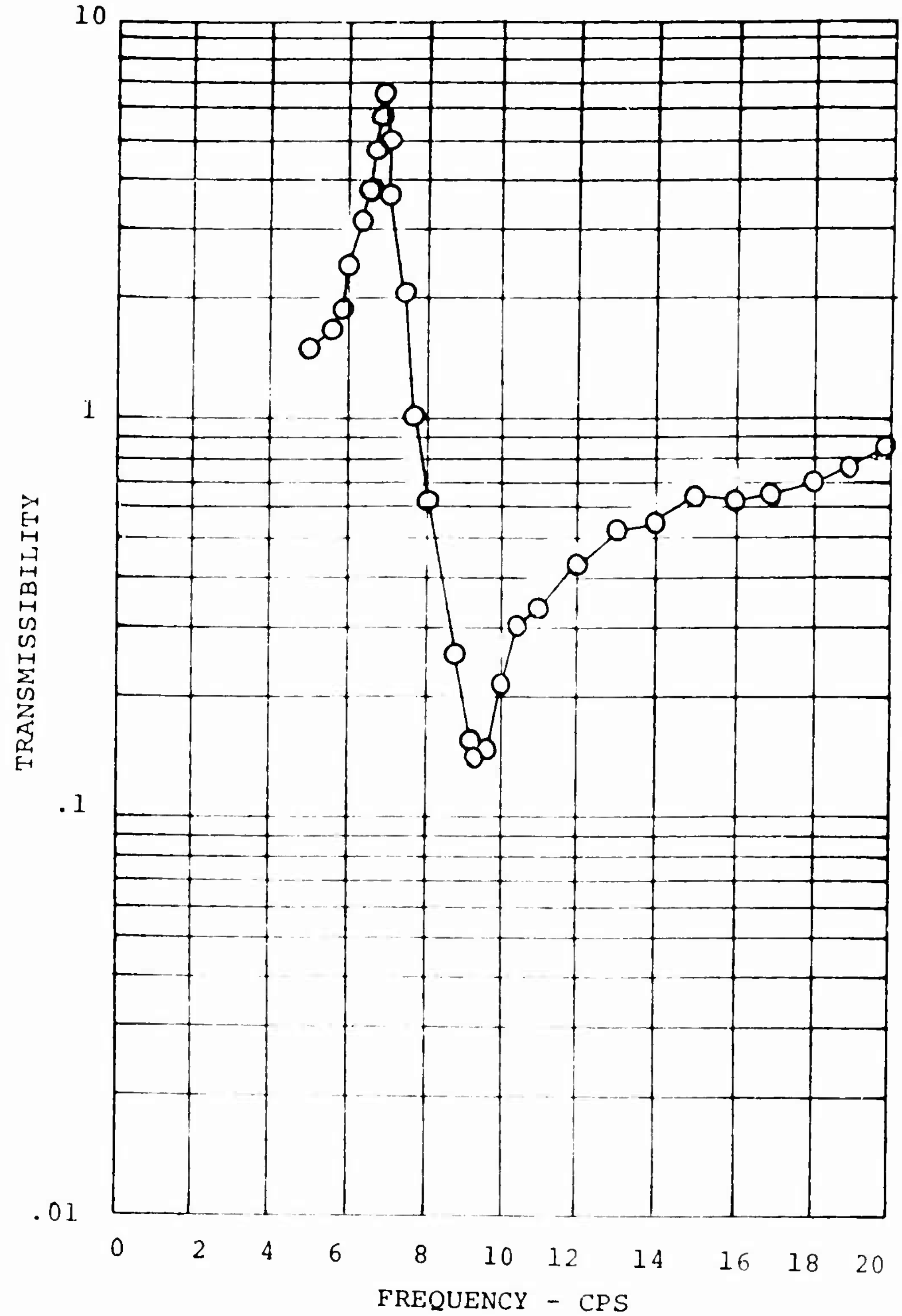


Figure 3. Vertical Transmissibility of the Preliminary Three-Dimensional DAVI Model for a Vertical Excitation.

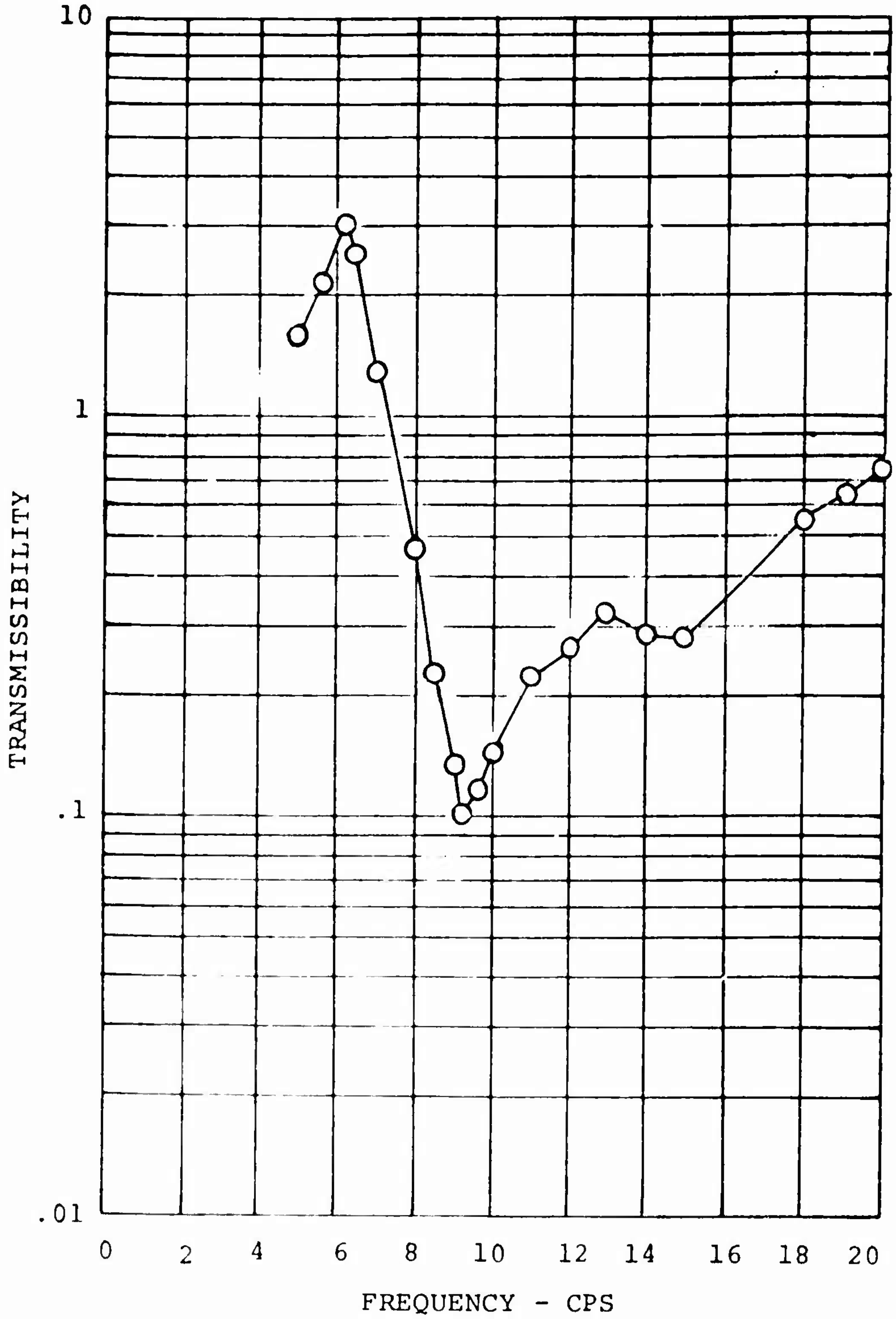


Figure 4. Longitudinal Transmissibility of the Preliminary Three-Dimensional DAVI Model for a Longitudinal Excitation.

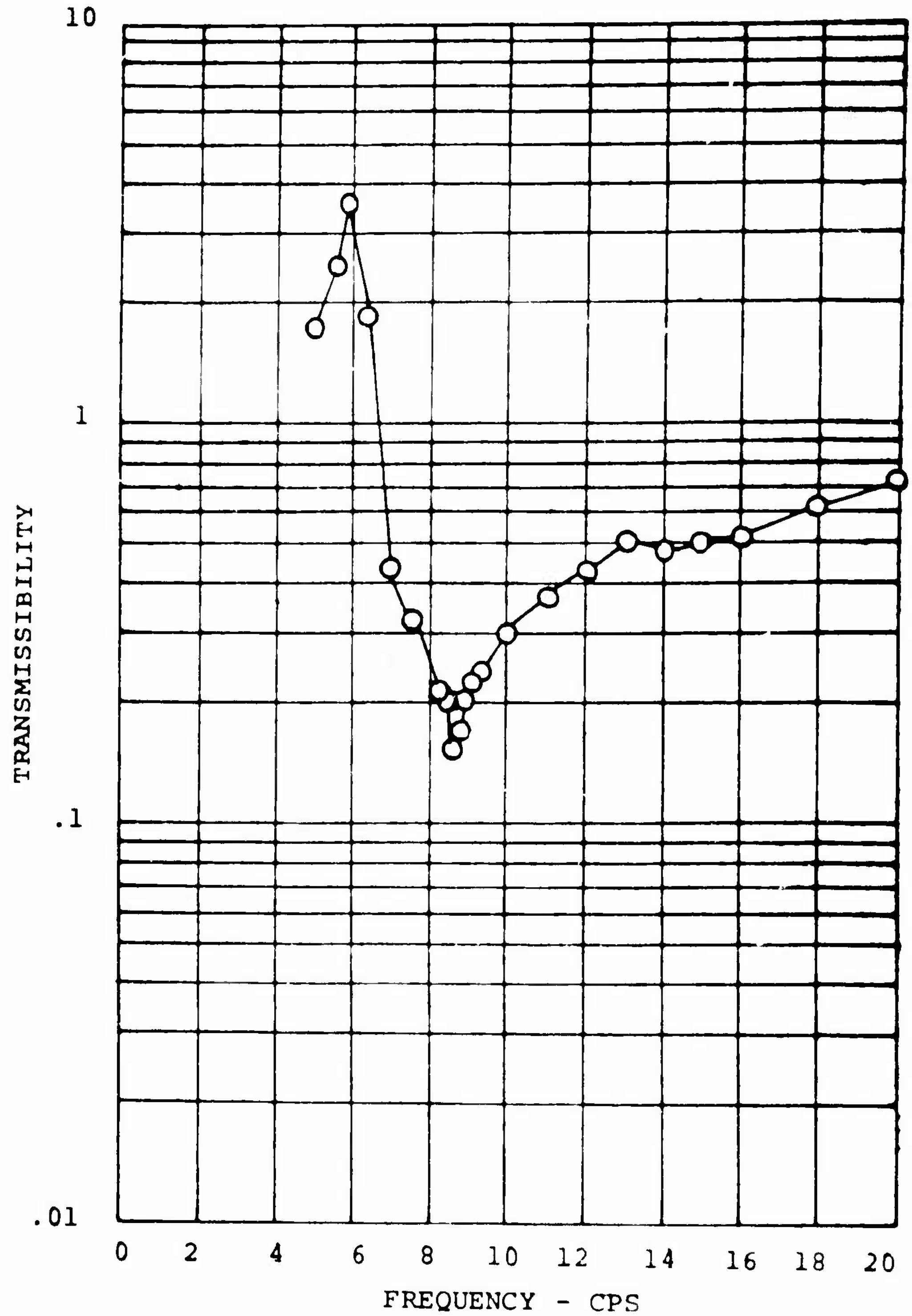


Figure 5. Lateral Transmissibility of the Preliminary Three-Dimensional DAVI Model for a Lateral Excitation.

TABLE II. COMPARISON OF ANTICIPATED AND TEST RESULTS

Principal Axis	Natural Frequency (cps)		Antiresonant Frequency (cps)		Transmissibility at Very High Frequency	
	Anticipated	Test	Anticipated	Test	Anticipated	Test
Vertical	6.9	7.0	9.0	9.3	.62	.82
Lateral	6.5	5.9	9.0	8.5	.50	.72
Longitudinal	6.5	6.1	9.0	9.3	.50	.70

Although typical DAVI transmissibility curves were obtained along each of the principal axes of the three-dimensional DAVI model, and reasonable agreement was obtained between anticipated and test results, there was a discrepancy in results obtained. The three-dimensional DAVI model had an antiresonant frequency of 9.3 cps for the excitation in the longitudinal direction and 8.5 cps for the excitation in the lateral direction. The results should be the same, since the spring rate is isotropic in the in-plane direction and the physical parameters of the two-dimensional inertia bar are identical in the longitudinal and lateral directions. However, for excitation in the longitudinal direction, the isolated pivot of the DAVI is offset from the elastic axis of the springs. This offset introduces a couple and causes rotation of the isolated body, and it therefore affects the antiresonants. This shows the need of designing the three-dimensional DAVI such that the isolated pivots are on the elastic axis of the spring system.

IMPROVED THREE-DIMENSIONAL DAVI MODEL

DESIGN

Figure 6 shows the schematic of the improved three-dimensional DAVI model. As in the preliminary model, this improved model has two inertia bars. The unidirectional inertia bar couples with motion along the vertical axis of the springs and utilizes Bendix pivots for the base or input pivot rather than the isolated pivot as in the preliminary model. This improved model also utilizes a spherical bearing for the isolated or output pivot. The isolated or output pivot is located between the cg of the unidirectional inertia bar and the base or input pivot. Therefore, the unidirectional inertia bar has a negative R/r. For motions of this unidirectional inertia bar, the weight of the two-dimensional inertia bar adds to the isolated weight.

The two-dimensional inertia bar couples with the in-plane motions of the springs and utilizes spherical bearings for both the isolated and base pivots. The base or input pivot of the two-dimensional inertia bar and the isolated or output pivot of the unidirectional inertia bar make up a common pivot. The isolated or output pivot is located between the cg of the inertia bar and the base or input pivot, and therefore the two-dimensional inertia bar has a negative R/r. For motions of the two-dimensional inertia bar, the weight of the unidirectional inertia bar adds to the base weight.

The isolated pivot of the unidirectional inertia bar is on the vertical elastic axis of the spring system, and the isolated pivot of the two-dimensional inertia bar is on the in-plane elastic axis of the spring system. Thus, the coupling effect within the DAVI has been minimized.

TEST EQUIPMENT AND PROCEDURE

Figure 7 shows the improved three-dimensional model used in the test, and Figure 8 shows an overall view of the test setup. In this figure, the upper platform is the isolated platform and the lower platform is the base platform. The total system is supported on conventional coil springs attached to the test stand. An electromagnetic shaker with a force capability of 50 pounds was connected to the base platform to provide the excitation. Four different tests were conducted for each isolated platform weight of 60 and 160 pounds.

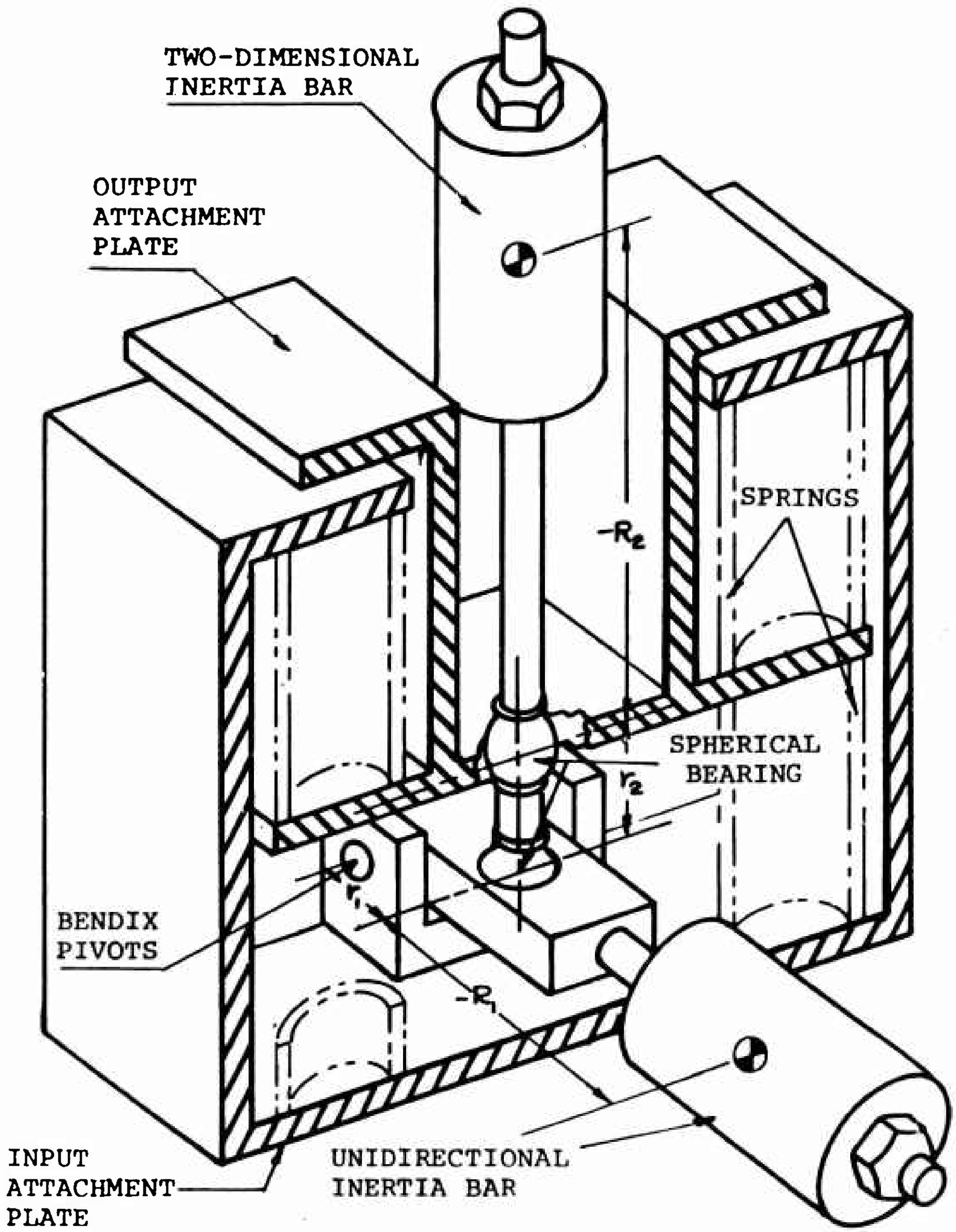


Figure 6. Schematic of the Improved Three-Dimensional DAVI Model.

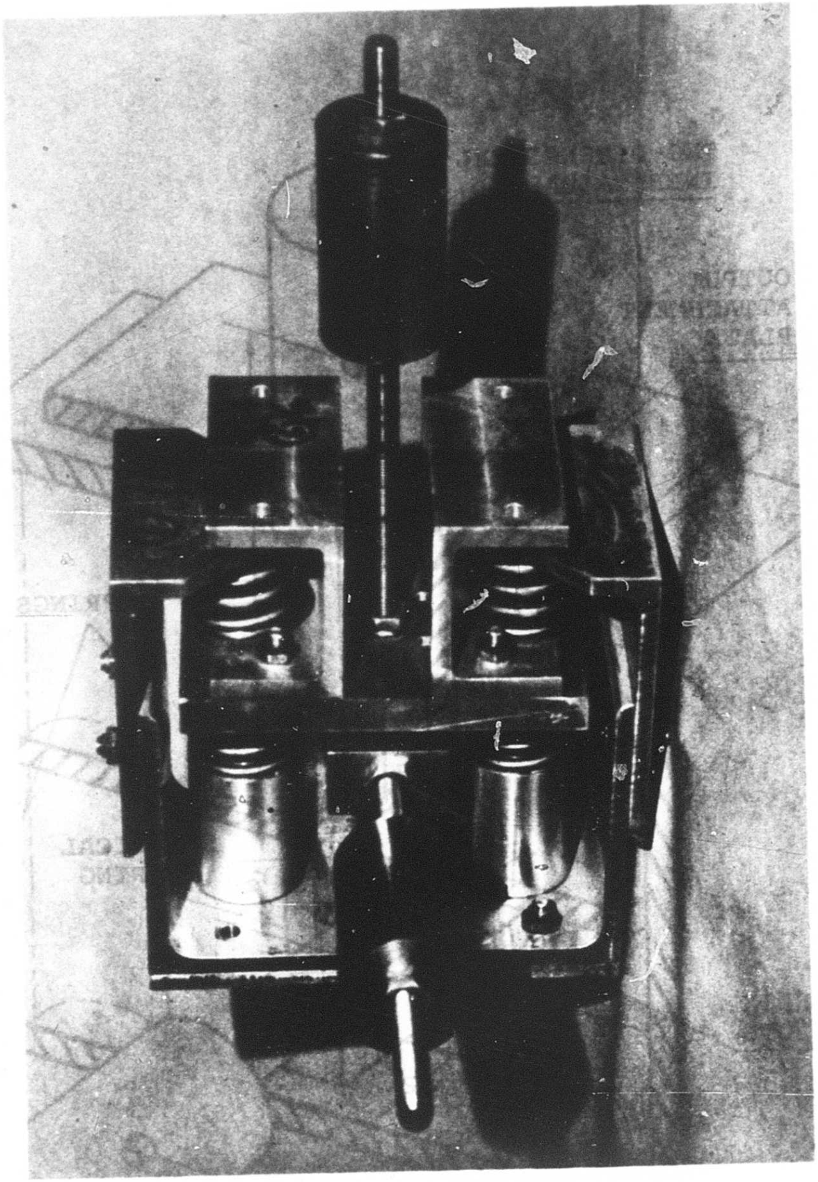


Figure 7. Improved Three-Dimensional DAVI Model.

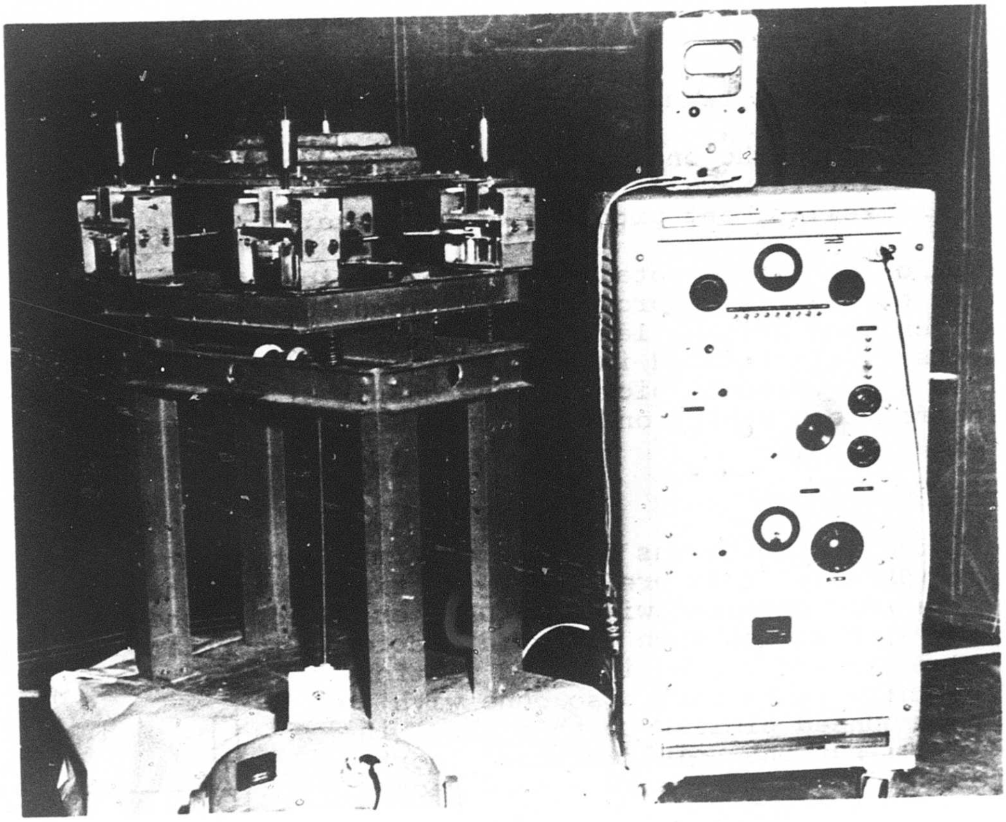


Figure 8. Test Setup of the Improved Three-Dimensional DAVI Model Isolated Platform.

For each of these weight configurations, a vibration survey was made from 5 cps to 20 cps for the following directions of excitation as shown in Figure 9:

1. Vertical translation of the base.

2. Longitudinal translation and pitching of the base.

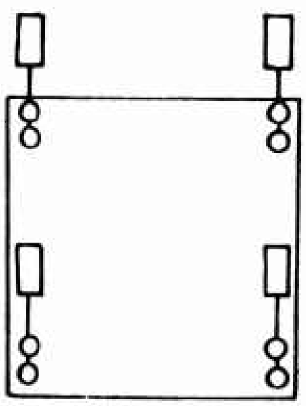
3. Lateral translation and rolling of the base.

4. Non-orthogonal input that introduced vertical, lateral and longitudinal translation with rolling and pitching of the base.

Vibration data were obtained at the vertical input and output of the four improved three-dimensional DAVI model locations and for the lateral and longitudinal inputs and outputs as illustrated in Figure 9. These data were obtained with velocity pickups, the output of the pickups being fed to a vibration meter and the results manually recorded.

TEST RESULTS

Preliminary testing was done to determine the best orientation of the DAVI's. This preliminary testing showed that the best results were obtained with the DAVI oriented as shown in Figure 9, that is, when the unidirectional inertia bars were oriented inward on the isolated platform. Preliminary tests were also done with the DAVI's mounted similar to that shown in Figure 9, but the unidirectional inertia bars were oriented in the same direction rather than inboard, as shown in the sketch. This orientation produced undesirable rolling and pitching of the platform, even though the isolated pivot is located at the elastic axis of the springs to minimize this problem. Pitching and rolling of the DAVI can occur because of the distance (r) between the isolated and base pivots. However, this pitching and rolling is minimized with the proper orientation of the DAVI's.



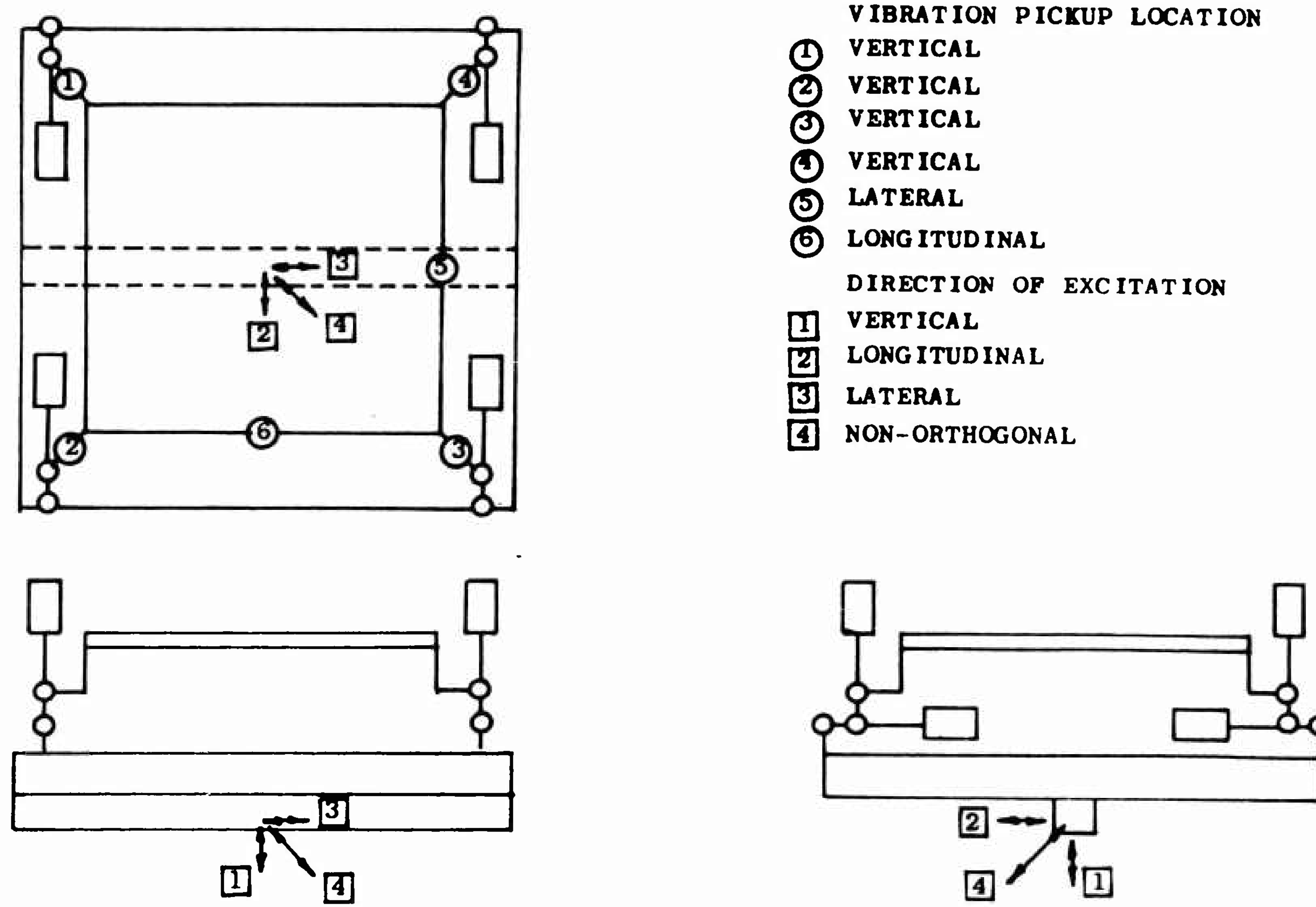


Figure 9. Schematic of Improved Three-Dimensional DAVI Model Isolated Platform.

Figures 10 through 37 give the results of the final tests. Figures 10 through 13 show the results obtained on the 60-pound and 160-pound three-dimensional DAVI isolated platform for a vertical excitation. It is seen from these results that typical DAVI transmissibility curves were obtained and that at the tuned frequency of the DAVI, excellent isolation was obtained for both the 60-pound and 160-pound DAVI isolated platform.

Figures 14 through 19 show the results obtained on the 60-pound and 160-pound three-dimensional DAVI isolated platform for a longitudinal excitation. The exciter was oriented such that longitudinal translation and pitching of the input platform were obtained. Figures 14 and 15 and Figures 17 and 18 show the vertical transmissibility obtained for the 60-pound and 160-pound platform, respectively. It is seen from these results that the weight of the platform did not affect the antiresonant frequency and that excellent isolation was obtained for the pitching input to the isolated platform. Figures 16 and 19 show the longitudinal transmissibility obtained for the 60-pound and 160-pound platform, respectively.

It is seen from these results that the 60-pound and 160-pound isolated platforms gave similar results. Three antiresonant frequencies were obtained rather than one because the platform is not a single-degree-of-freedom system but a multi-degree-of-freedom system, and a typical single-degree-of-freedom DAVI transmissibility curve with one antiresonant frequency will not be obtained. However, the antiresonance obtained at 10.8 cps is at the tuned frequency of the DAVI, and this antiresonant frequency was not affected by the weight of the platform.

Figures 20 through 25 show the results obtained on the 60-pound and 160-pound three-dimensional DAVI isolated platform for a lateral excitation. The exciter was oriented such that lateral translation and rolling of the input platform were obtained. It is seen that results obtained from this direction of excitation were similar to those in the longitudinal direction of excitation. Antiresonances were obtained in the vertical and lateral directions at the tuned frequency of the DAVI, and these antiresonances were not affected by the weight of the platform. However, the transmissibility in the vertical direction of the DAVI was not as good as that in the longitudinal direction of excitation. The isolation due to the rolling input was not as good as that due to a pitching input. Therefore, orientation in the direction of the DAVI inertia bars can influence the magnitude of isolation obtained.

Figures 26 through 37 show the results obtained on the 60-pound and 160-pound three-dimensional DAVI isolated platforms for a nonorthogonal direction of excitation. The direction of excitation was such that it was not normal to either of the two DAVI inertia bars and such that vertical, lateral, and longitudinal translation with pitching and rolling of the input platform was obtained. The data in Figures 26 through 37 are presented in the form of relative velocities, all normalized to the input vertical velocity at position one. The data are presented in this manner to better illustrate the input to the isolated platform and to better illustrate the magnitude of vibration reduction obtained on the three-dimensional DAVI isolated platform.

Figures 26 and 27 and Figures 32 and 33 show the vertical input to the 60-pound and 160-pound three-dimensional DAVI isolated platforms, respectively. It can be seen from these figures that not only vertical translation but also a large magnitude of pitching and rolling was introduced to the isolated platform.

Figures 28 and 29 and Figures 34 and 35 show the vertical output of the 60-pound and the 160-pound three-dimensional DAVI isolated platforms, respectively. It is seen from these curves that at the tuned frequency of the DAVI, minimum vibration of the platform was obtained. Not only was translation of the platform reduced, but pitching and rolling of the platform were also reduced. It is also seen that the weight of the isolated platform did not affect the tuned frequency of the DAVI.

Figures 30 and 36 show the longitudinal results of the input and output of the 60-pound and the 160-pound three-dimensional DAVI isolated platforms, respectively, and Figures 31 and 37 show the lateral results of the input and output of the 60-pound and the 160-pound three-dimensional DAVI isolated platforms, respectively. It is seen from these results that good isolation was obtained in both directions for the 60-pound and the 160-pound three-dimensional DAVI isolated platforms.

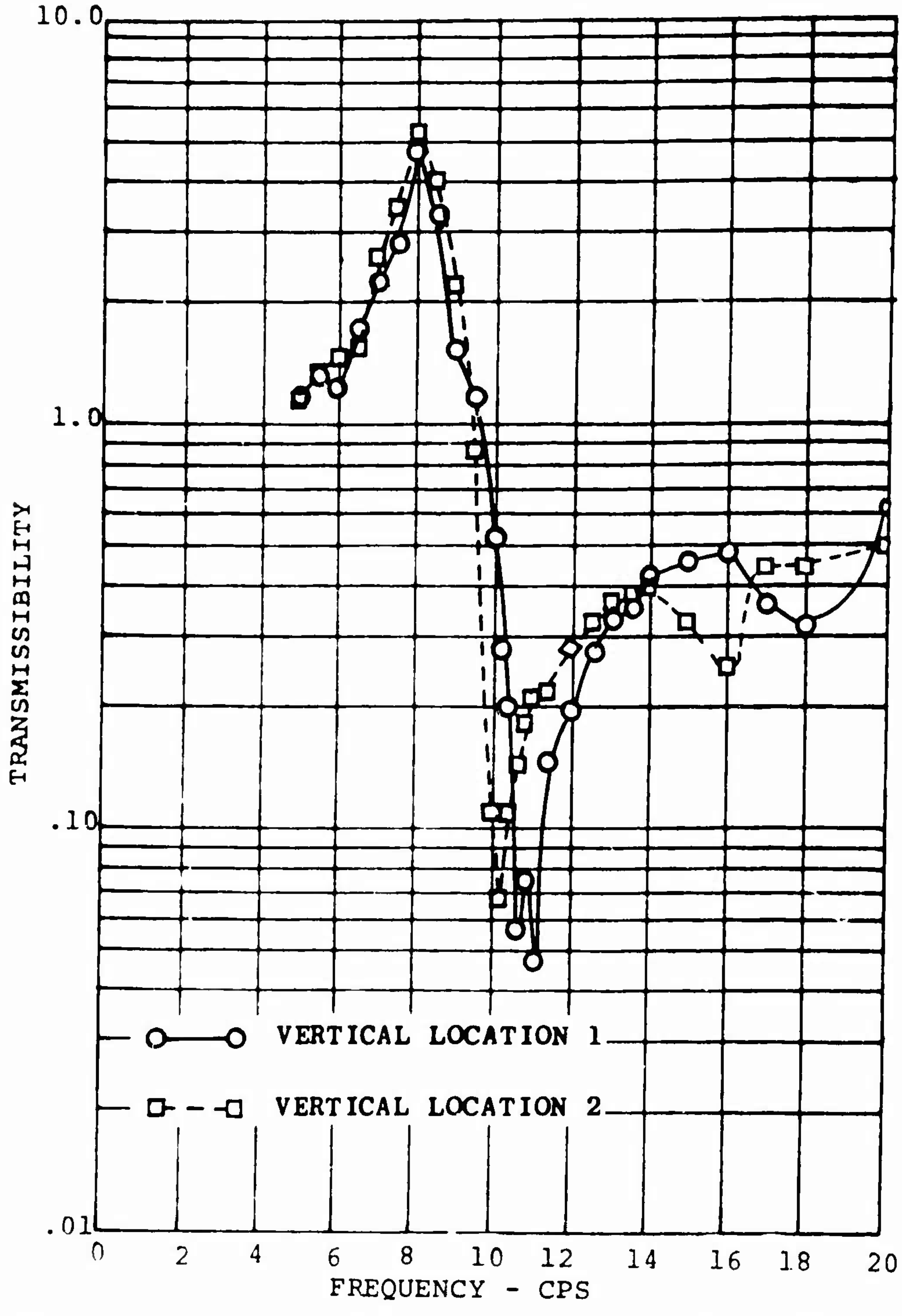


Figure 10. Vertical Transmissibility of the 60-Pound Three-Dimensional DAVI Platform for a Vertical Excitation.

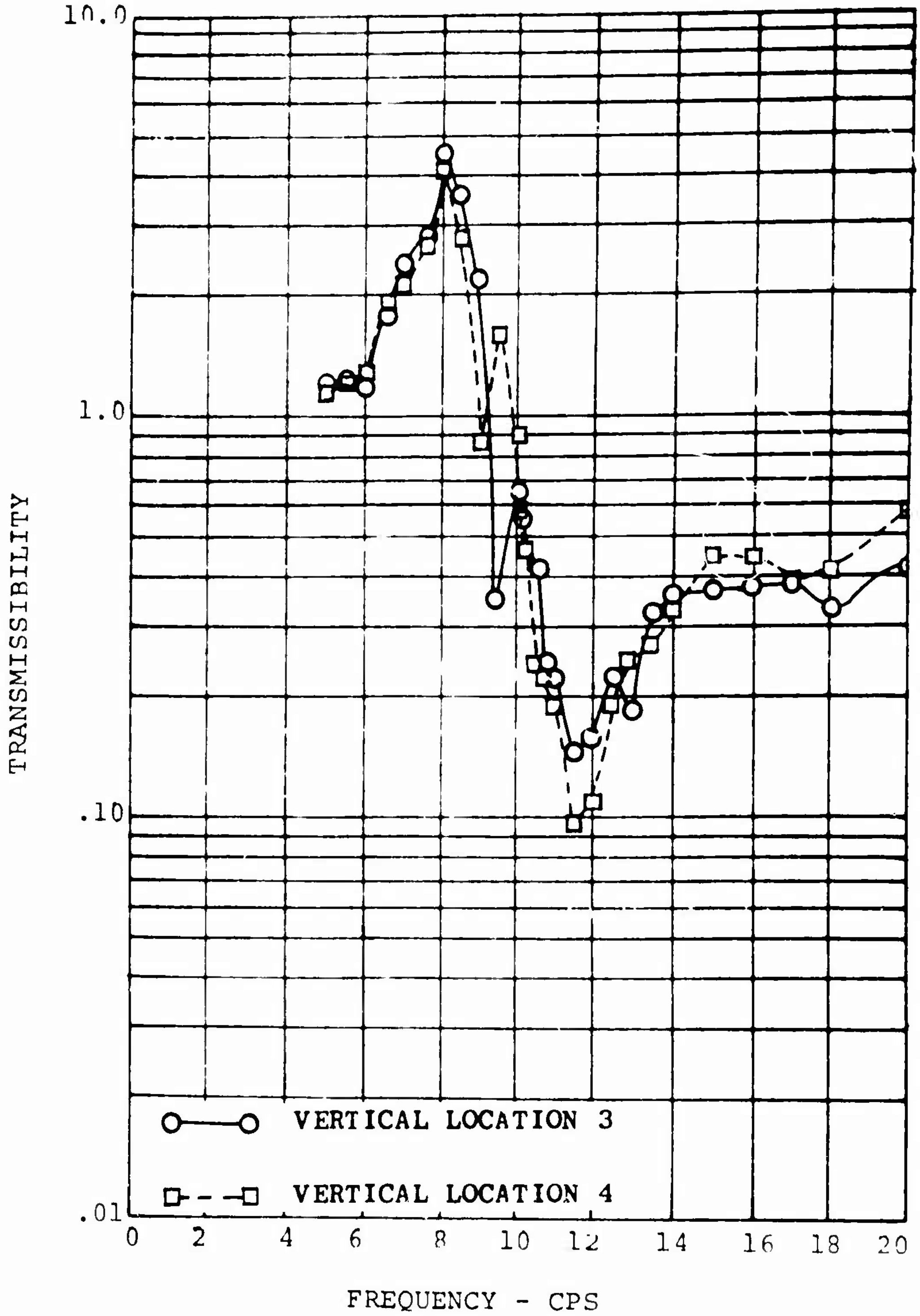


Figure 11. Vertical Transmissibility of the 60-Pound Three-Dimensional DAVI for a Vertical Excitation.

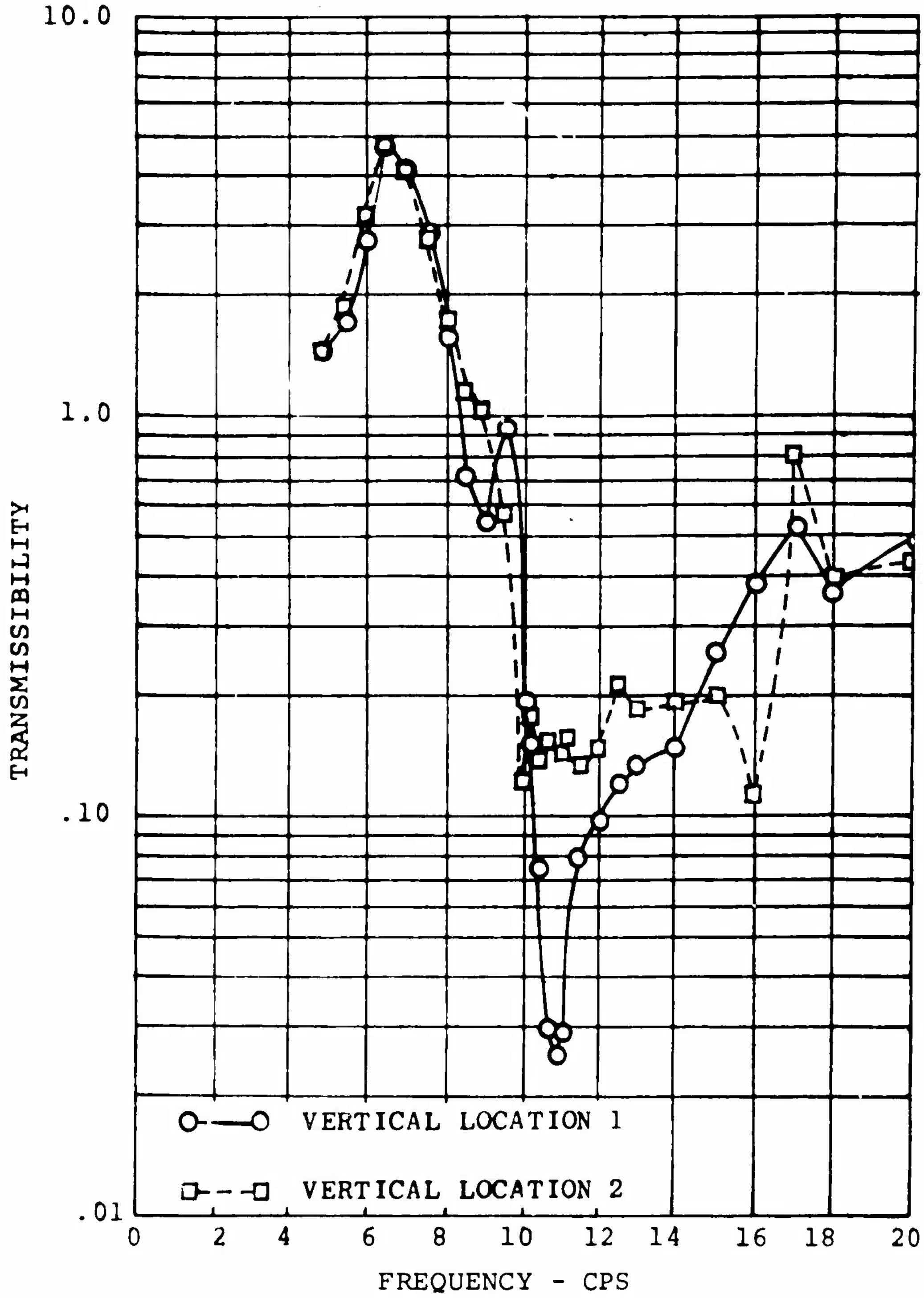


Figure 12. Vertical Transmissibility of the 160-Pound Three-Dimensional DAVI Platform for a Vertical Excitation.

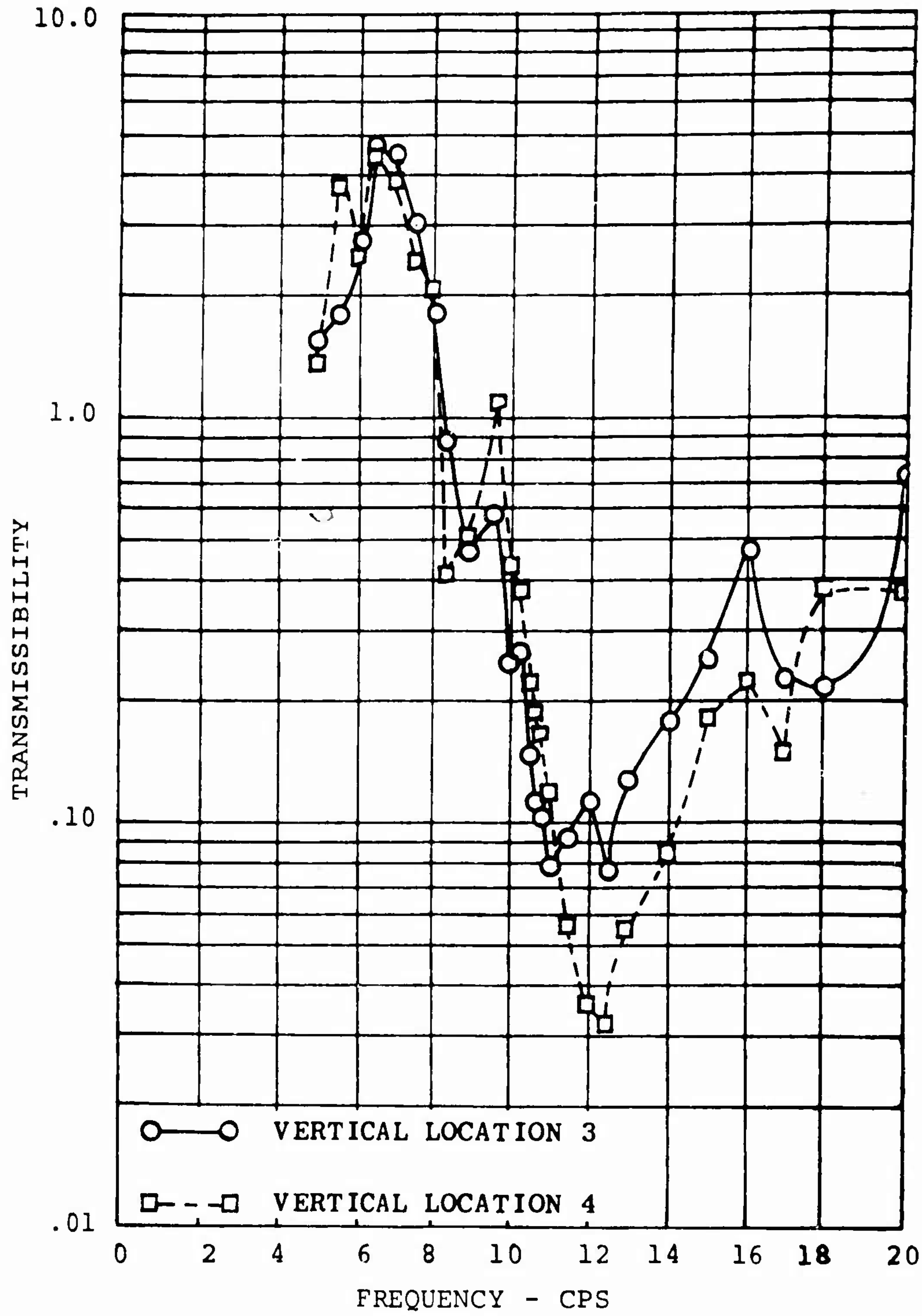


Figure 13. Vertical Transmissibility of the 160-Pound Three-Dimensional DAVI Platform for a Vertical Excitation.

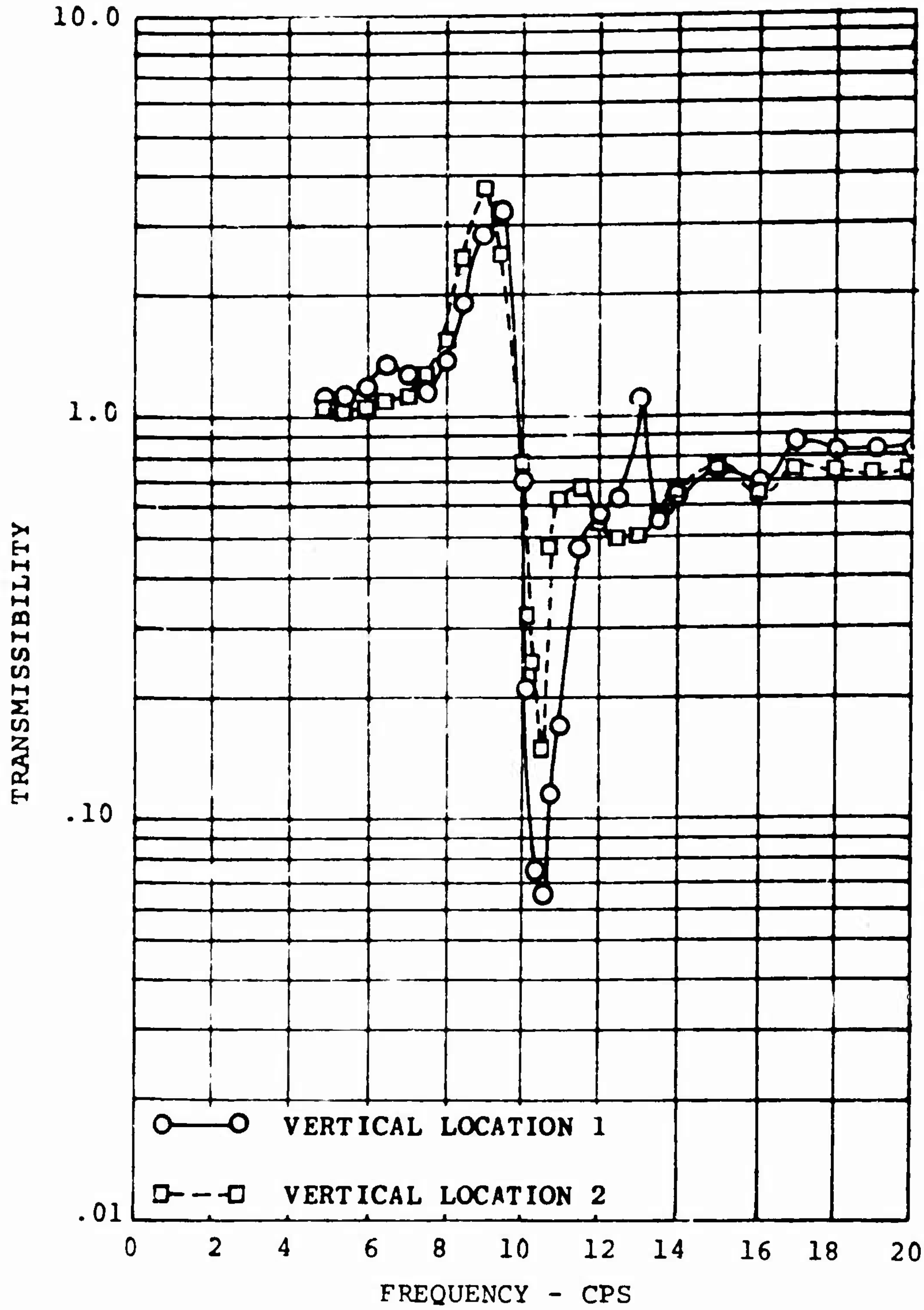


Figure 14. Vertical Transmissibility of the 60-Pound Three-Dimensional DAVI Platform for a Longitudinal Excitation.

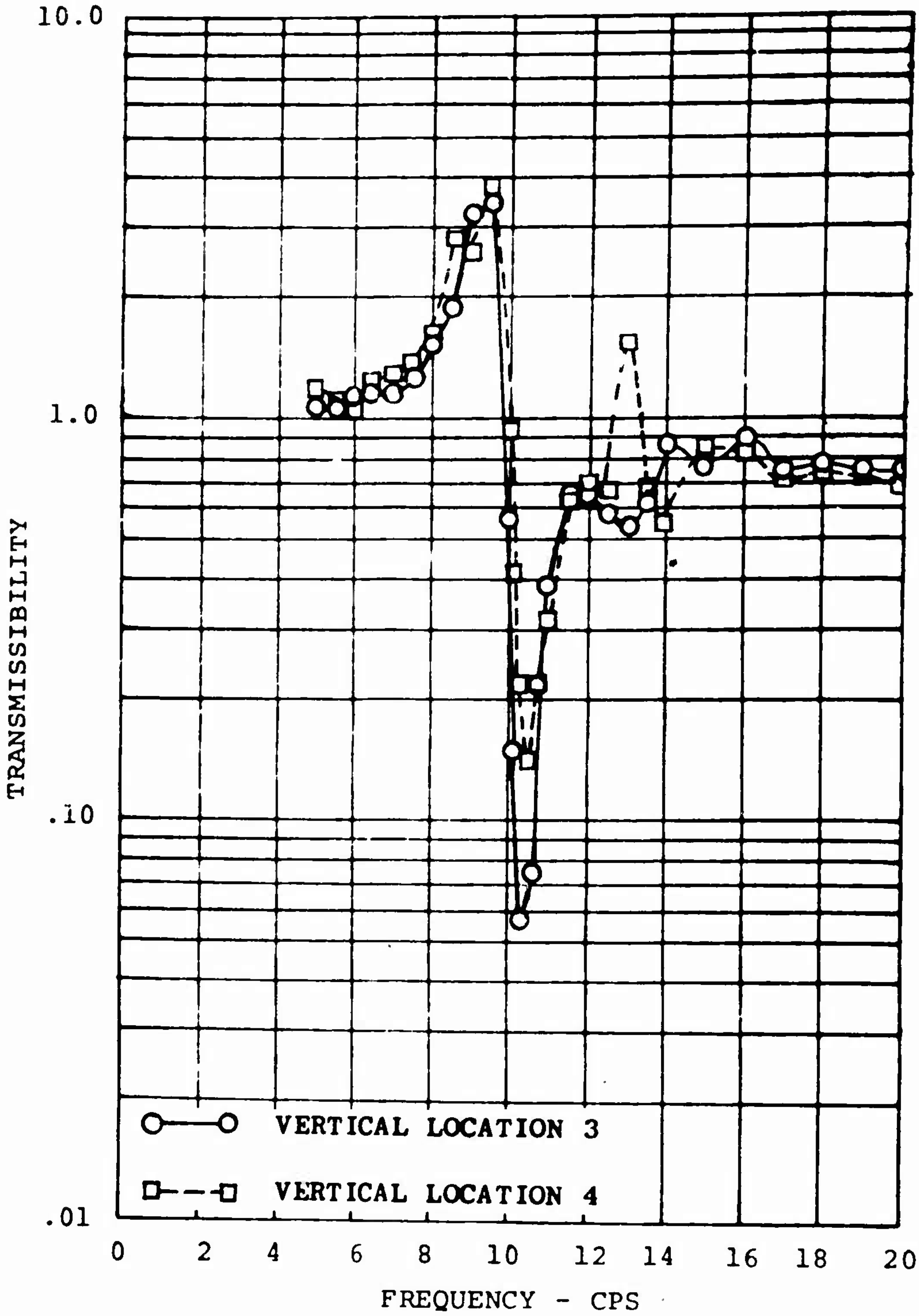


Figure 15. Vertical Transmissibility of the 60-Pound Three-Dimensional DAVI Platform for a Longitudinal Excitation.

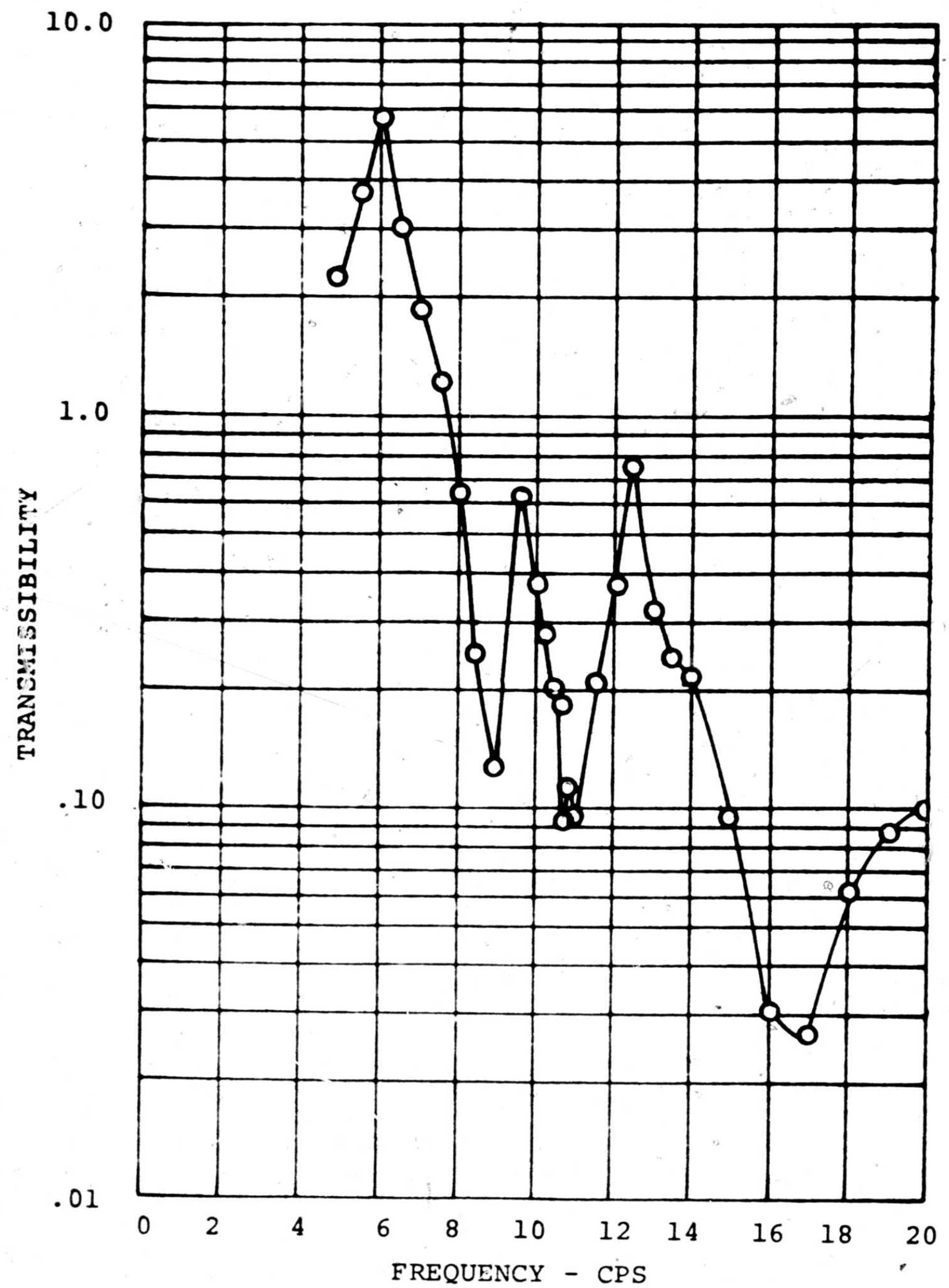


Figure 16. Longitudinal Transmissibility of the 60-Pound Three-Dimensional DAVI Platform for a Longitudinal Excitation.

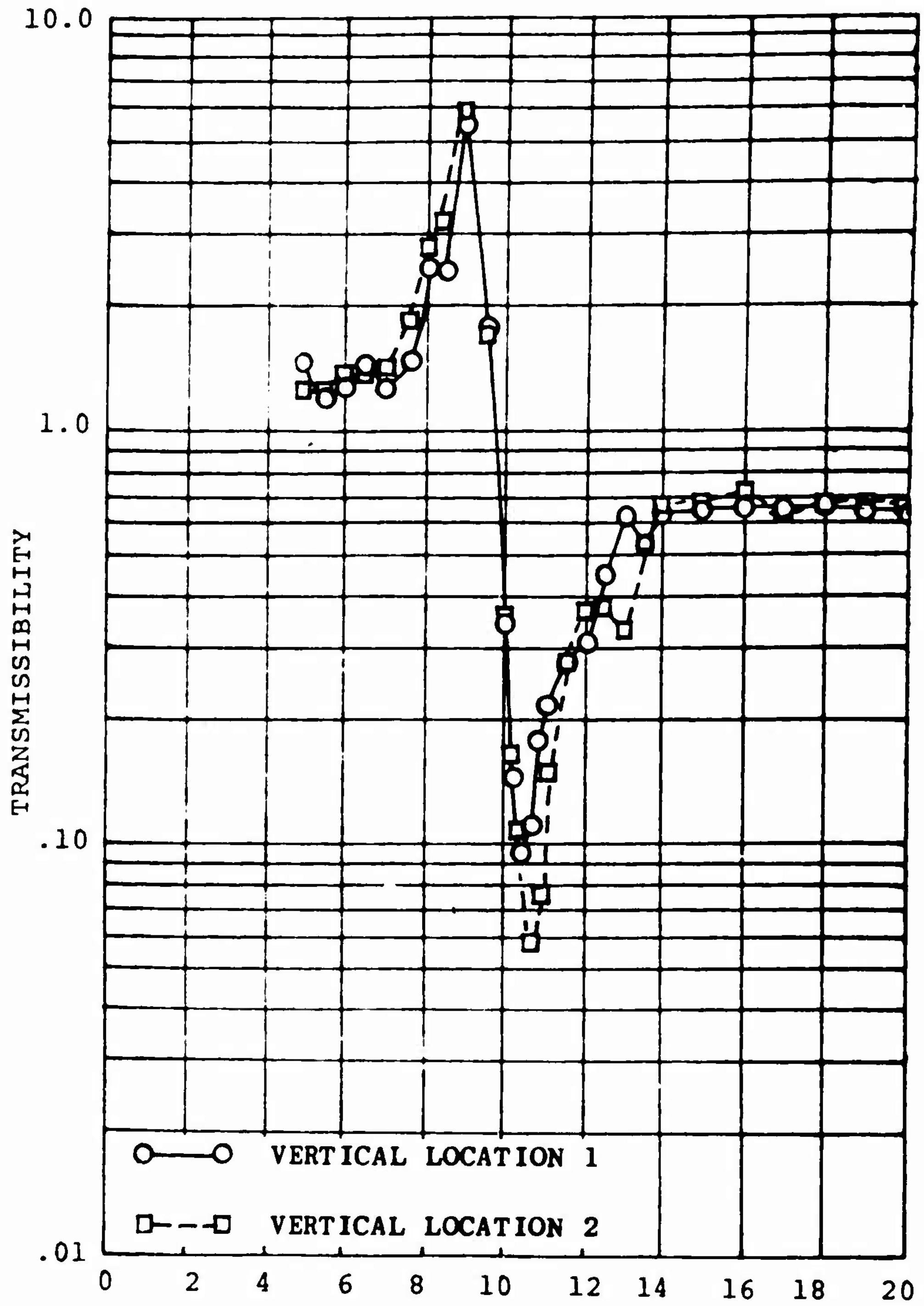


Figure 17. Vertical Transmissibility of the 160-Pound Three-Dimensional DAVI Platform for a Longitudinal Excitation.

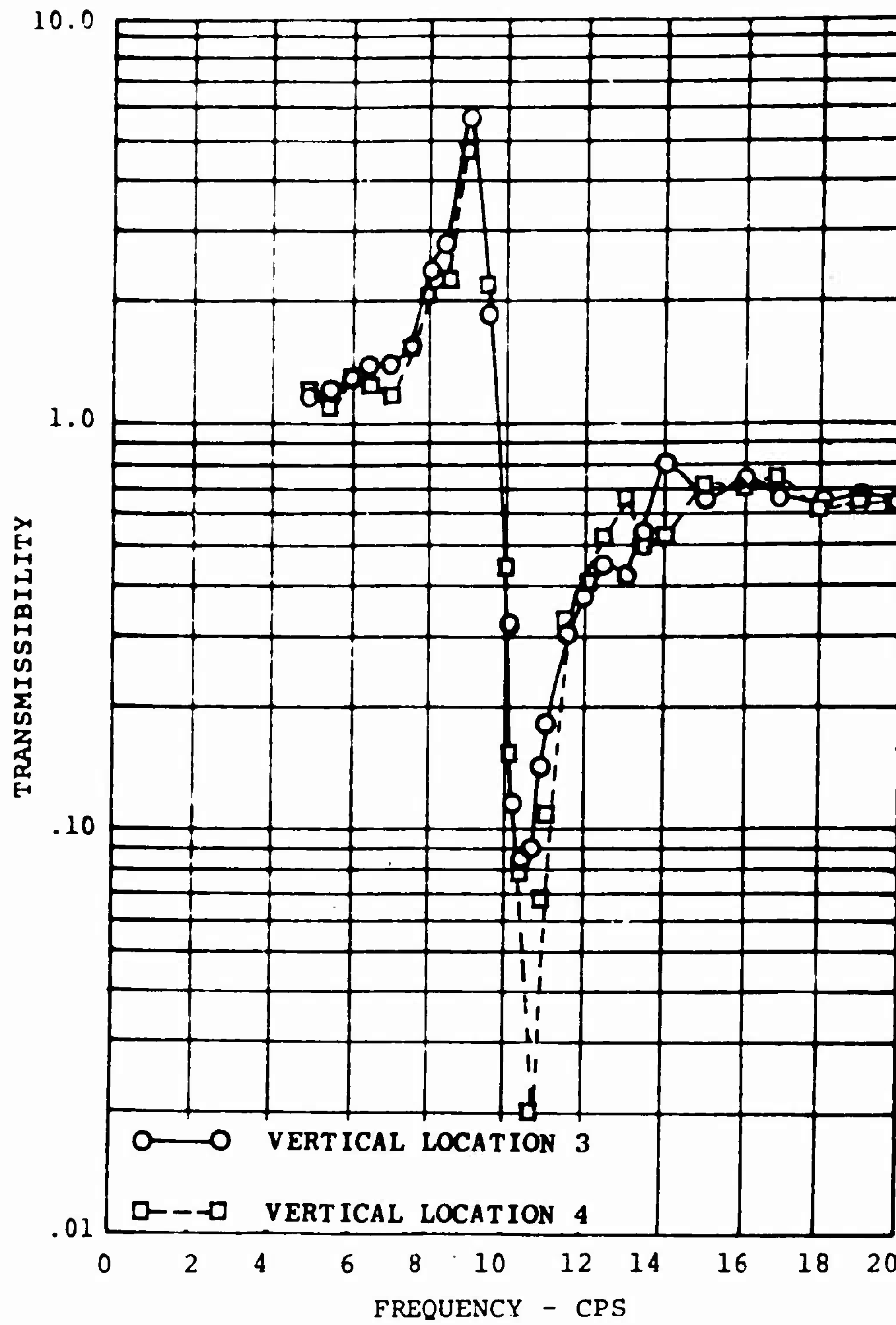


Figure 18. Vertical Transmissibility of the 160-Pound Three-Dimensional DAVI Platform for a Longitudinal Excitation.

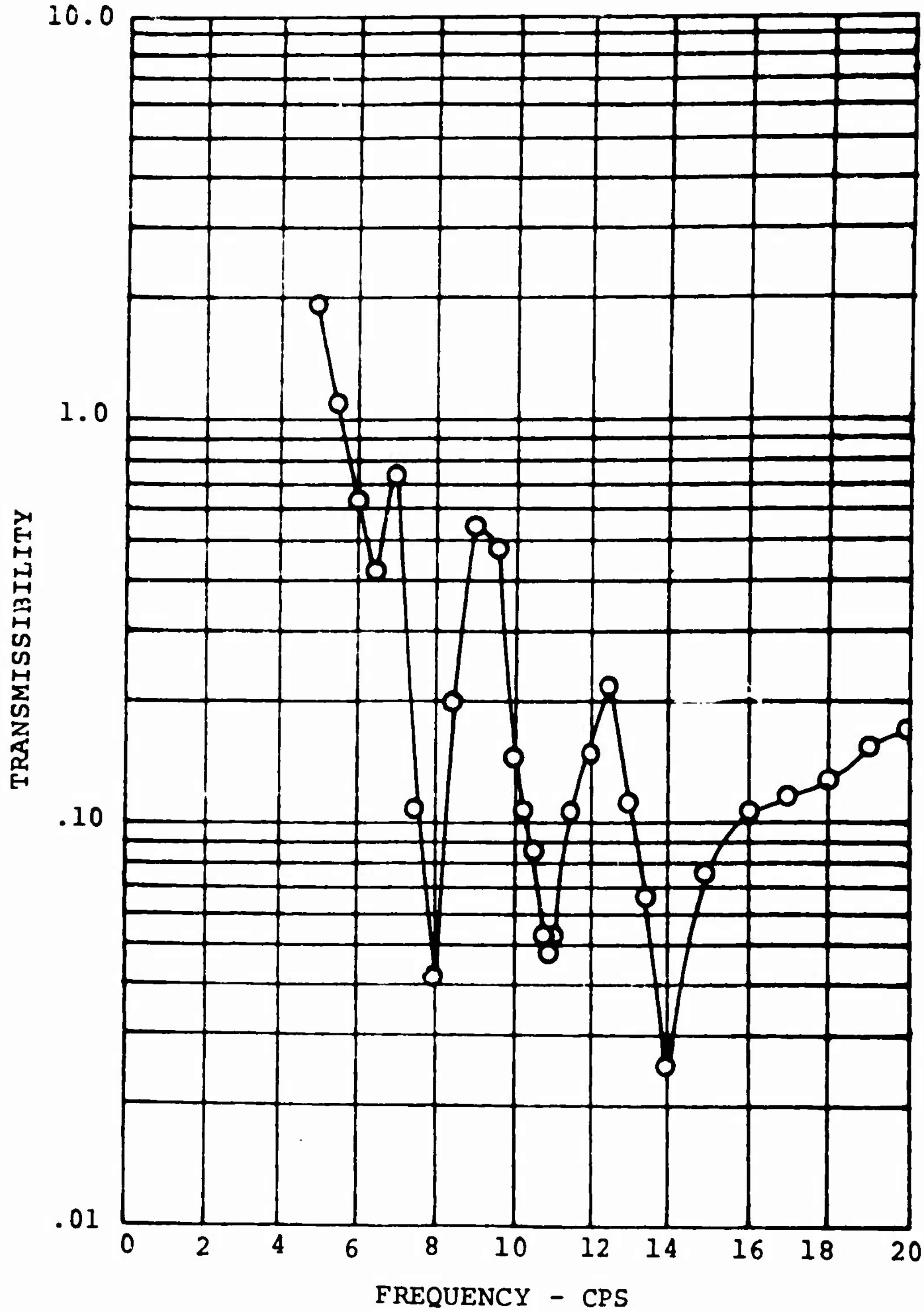


Figure 19. Longitudinal Transmissibility of the 160-Pound Three-Dimensional DAVI Platform for a Longitudinal Excitation.

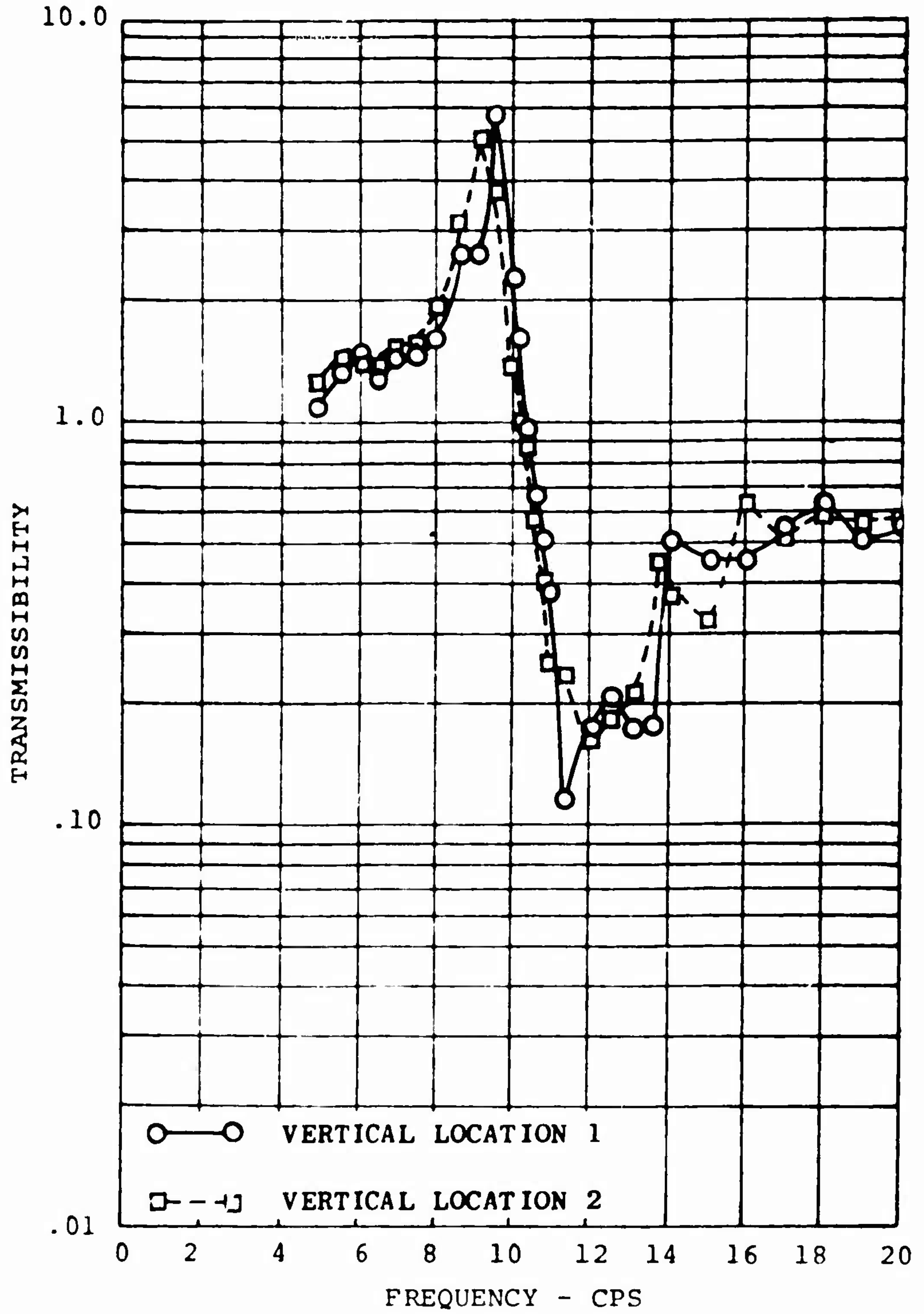


Figure 20. Vertical Transmissibility of the 60-Pound Three-Dimensional DAVI Platform for a Lateral Excitation.

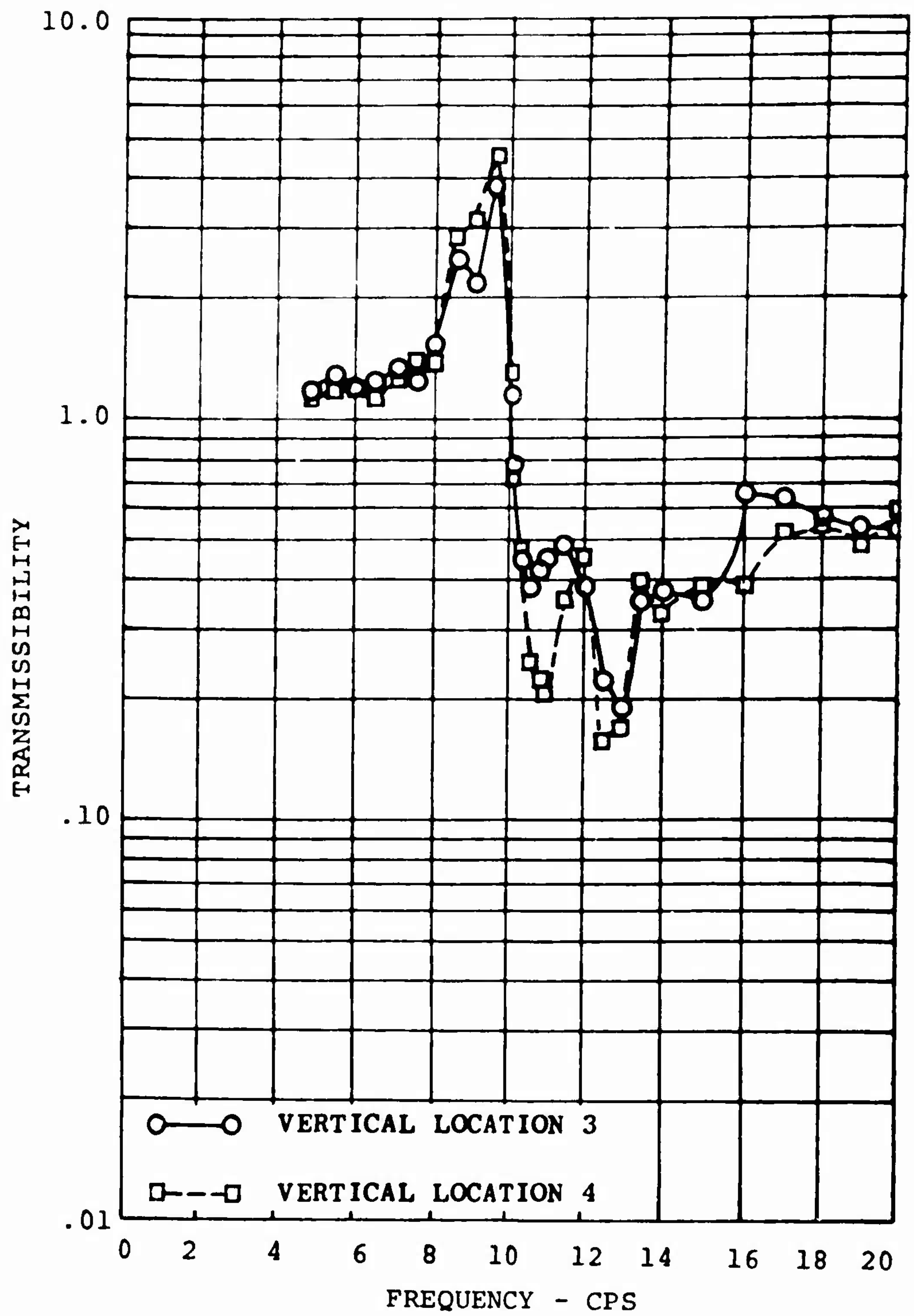


Figure 21. Vertical Transmissibility of the 60-Pound Three-Dimensional DAVI Platform for a Lateral Excitation.

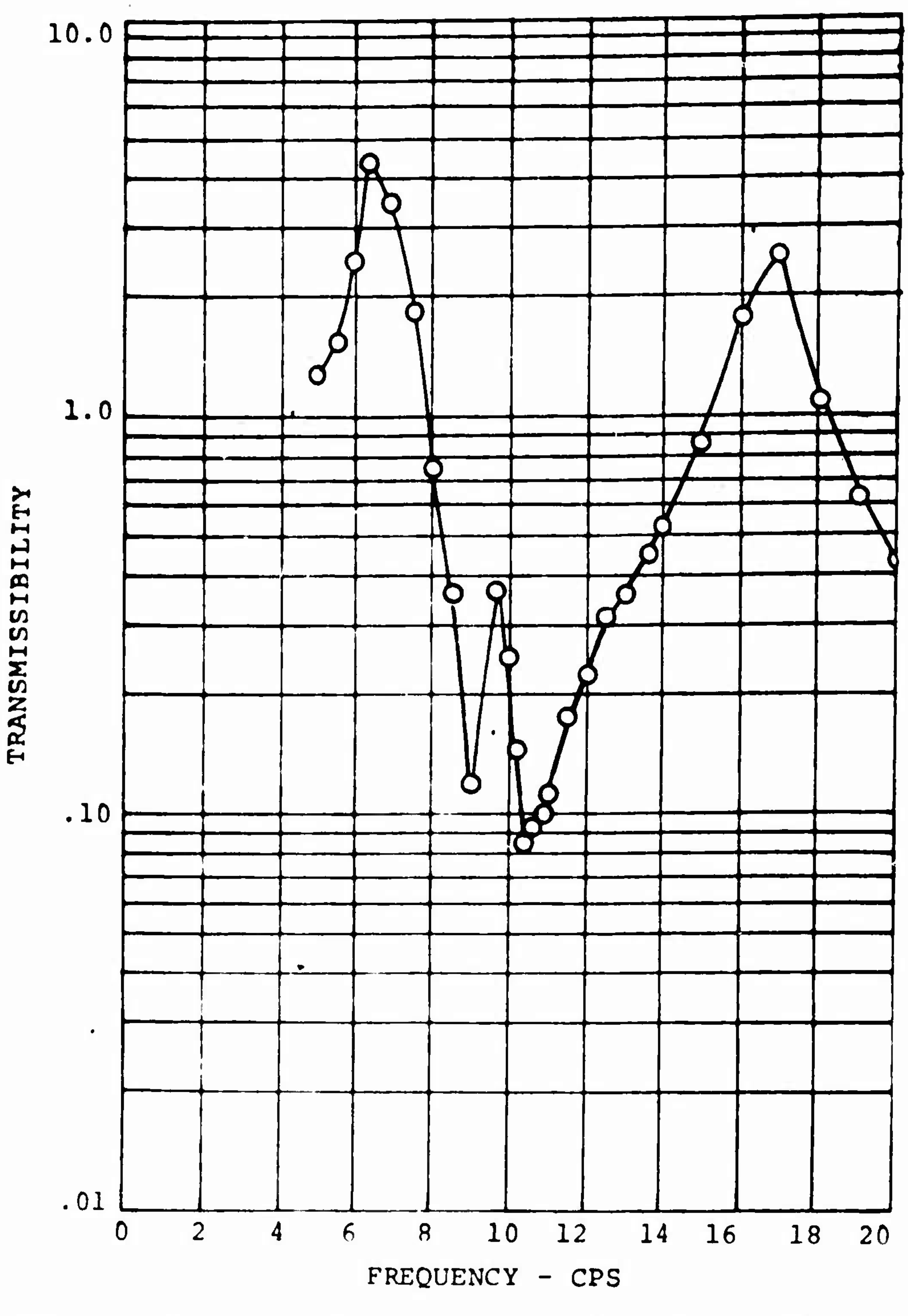


Figure 22. Lateral Transmissibility of the 60-Pound Three-Dimensional DAVI Platform for a Lateral Excitation.

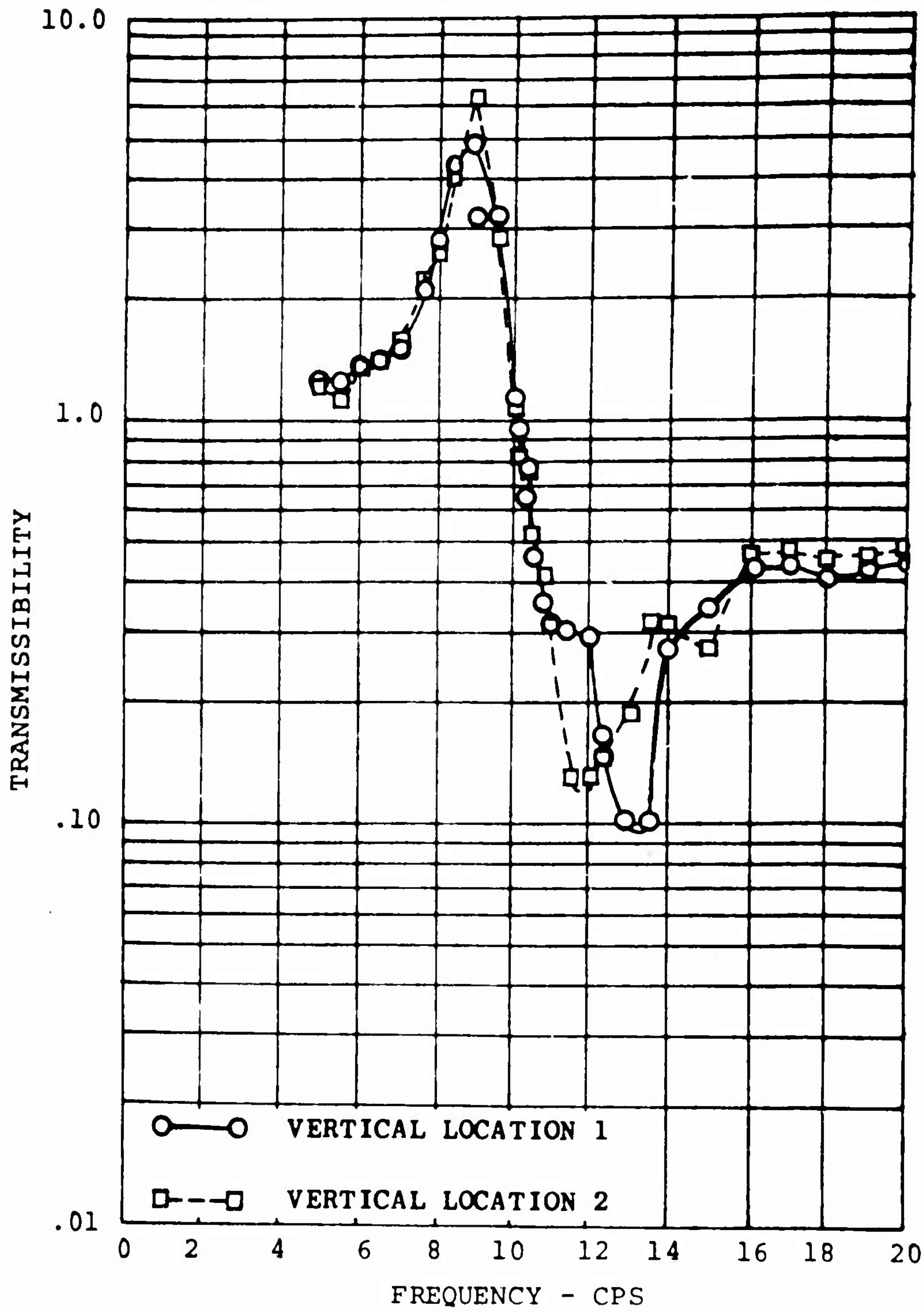


Figure 23. Vertical Transmissibility of the 160-Pound Three-Dimensional DAVI Platform for a Lateral Excitation.

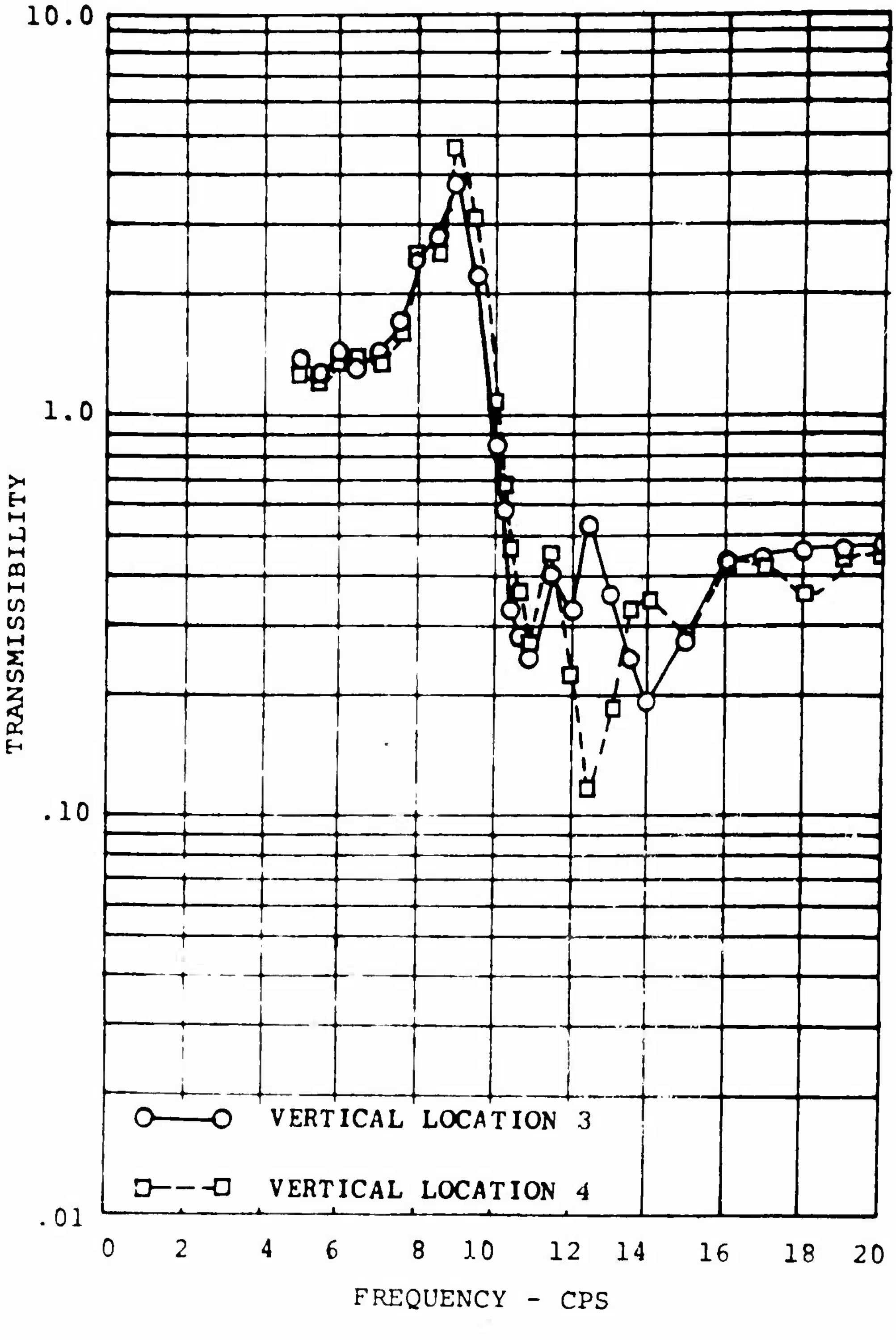


Figure 24. Vertical Transmissibility of the 160-Pound Three-Dimensional DAVI Platform for a Lateral Excitation

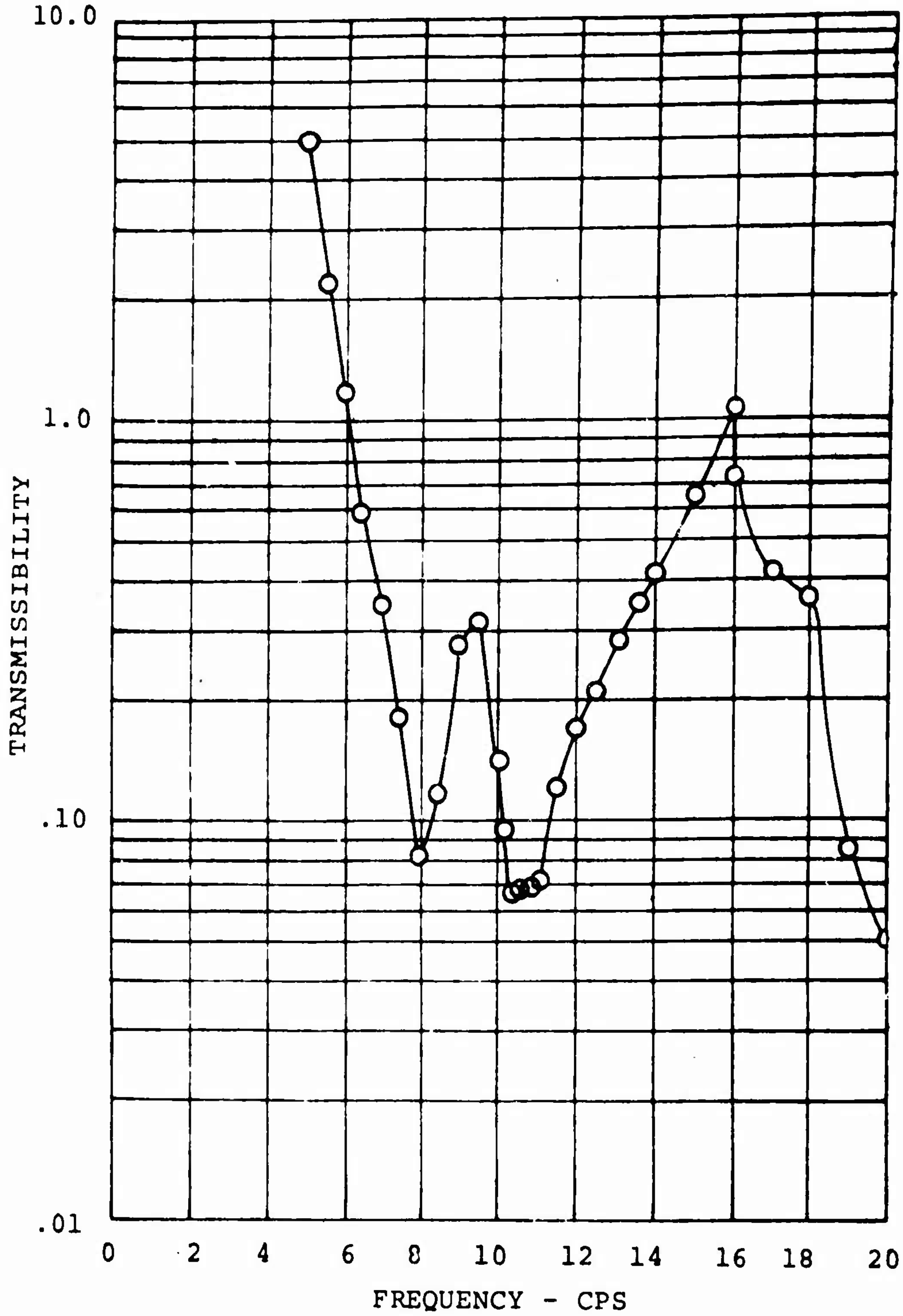


Figure 25. Lateral Transmissibility of the 160-Pound Three-Dimensional DAVI Platform for a Lateral Excitation.

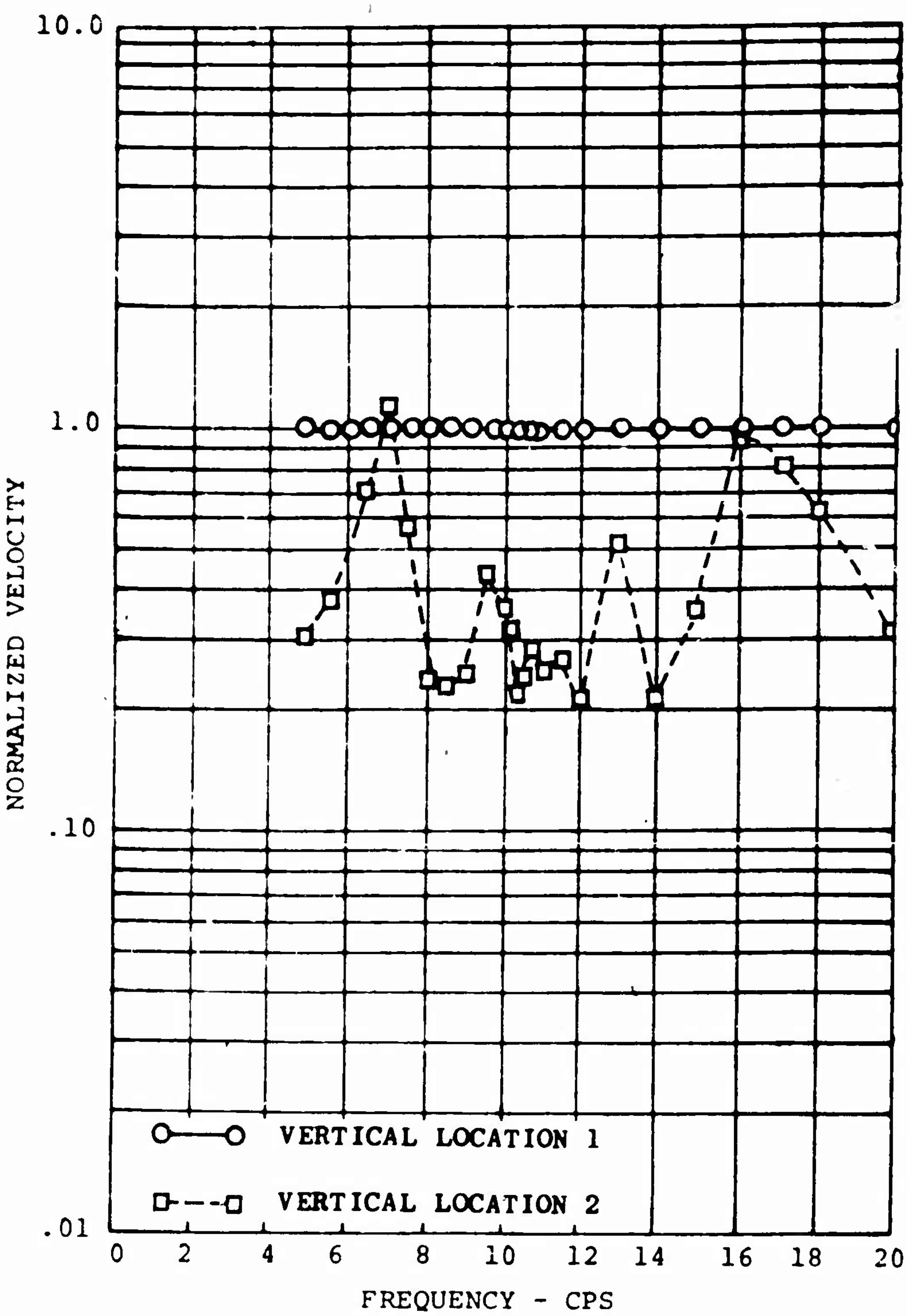


Figure 26. Normalized Vertical Velocity Input of the 60-Pound Three-Dimensional DAVI Platform for a Non-Orthogonal Excitation.

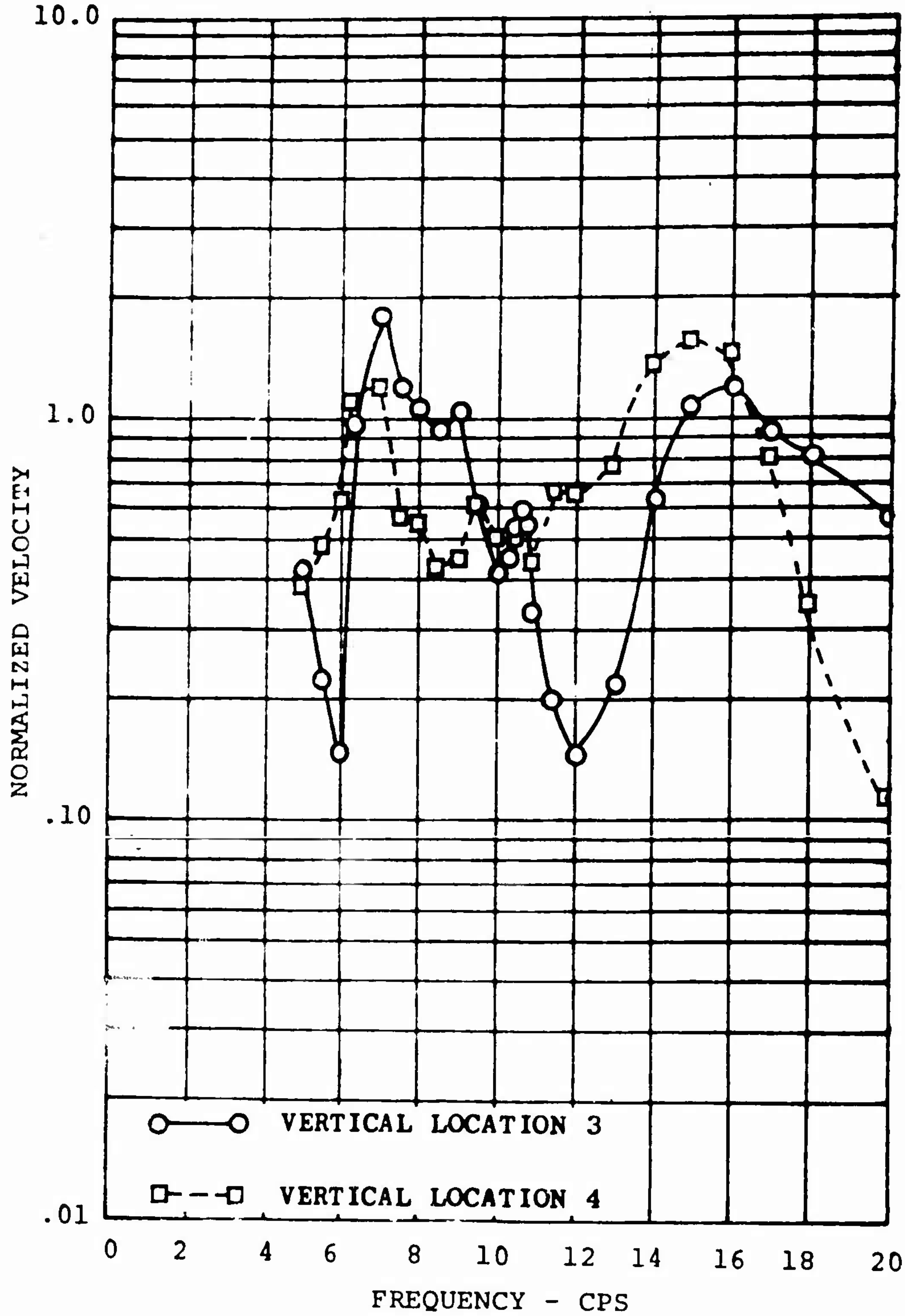


Figure 27. Normalized Vertical Velocity Input of the 60-Pound Three-Dimensional DAVI Platform for a Non-Orthogonal Excitation.

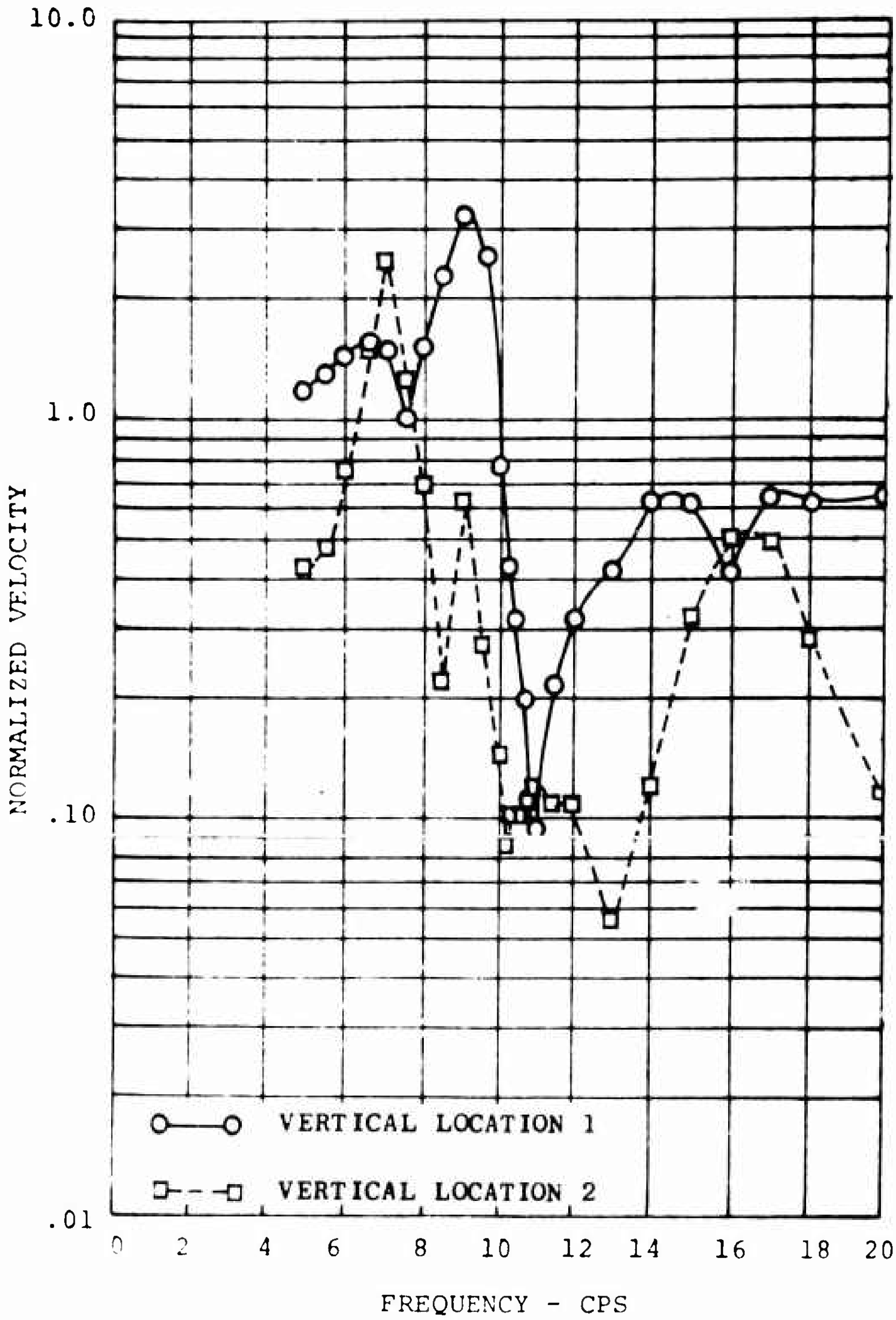


Figure 28. Normalized Vertical Velocity Output of the 60-Pound Three-Dimensional DAVI Platform for a Non-Orthogonal Excitation.

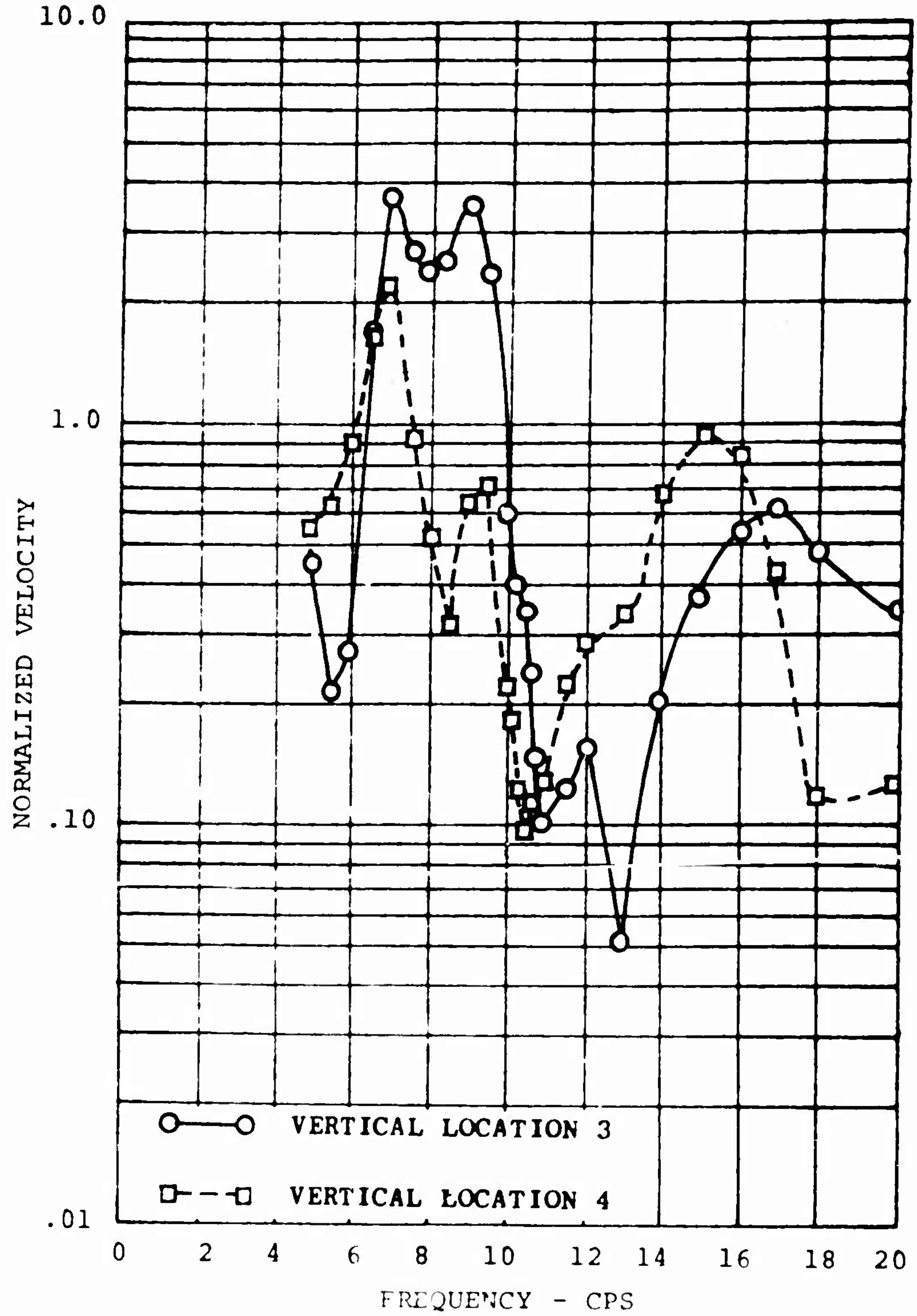


Figure 29. Normalized Vertical Velocity Output of the 60-Pound Three-Dimensional DAVI Platform for a Non-Orthogonal Excitation.

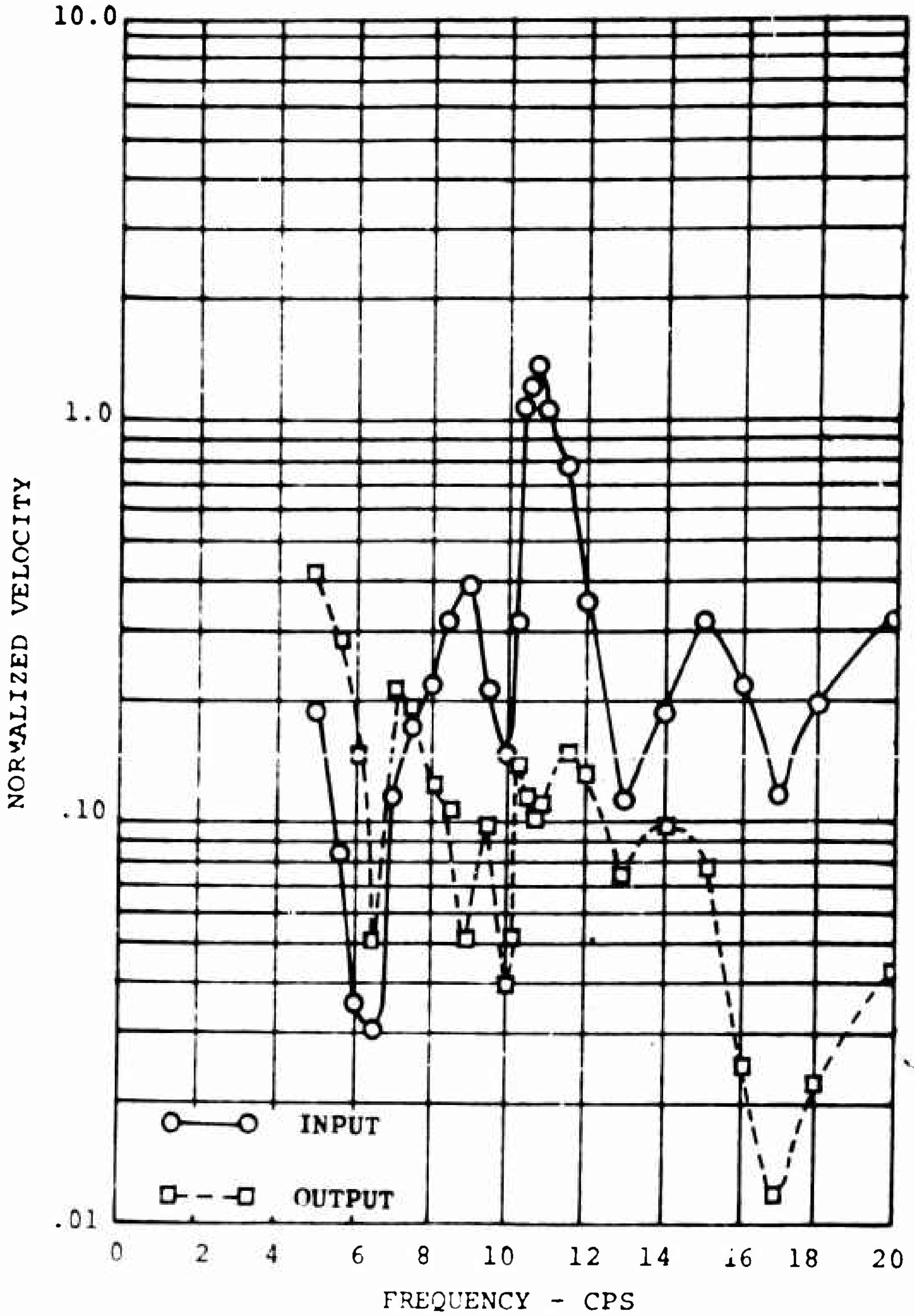


Figure 30. Normalized Longitudinal Velocity of the 60-Pound Three-Dimensional DAVI Platform for a Non-Orthogonal Excitation.

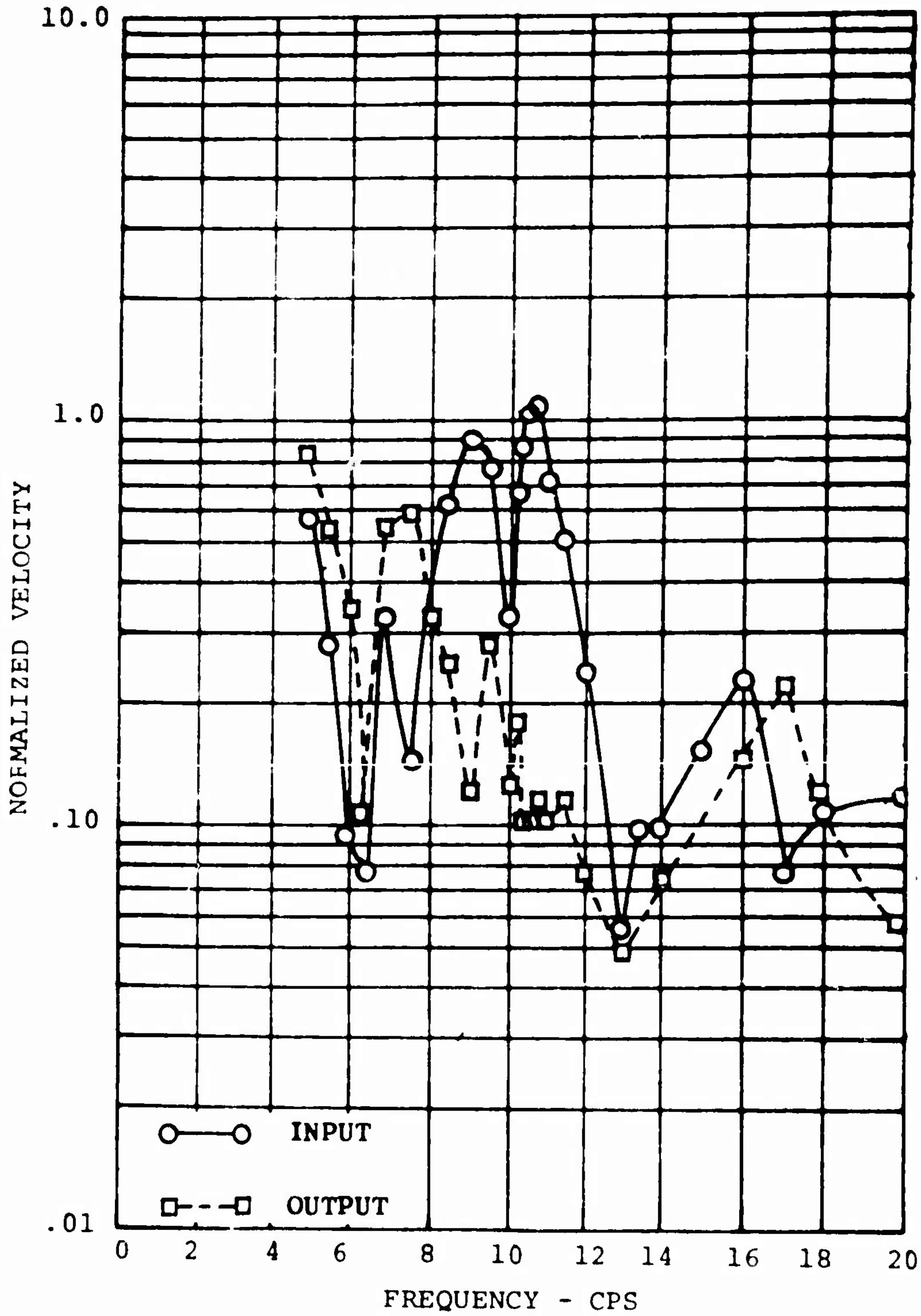


Figure 31. Normalized Lateral Velocity of the 60-Pound Three-Dimensional DAVI Platform for a Non-Orthogonal Excitation.

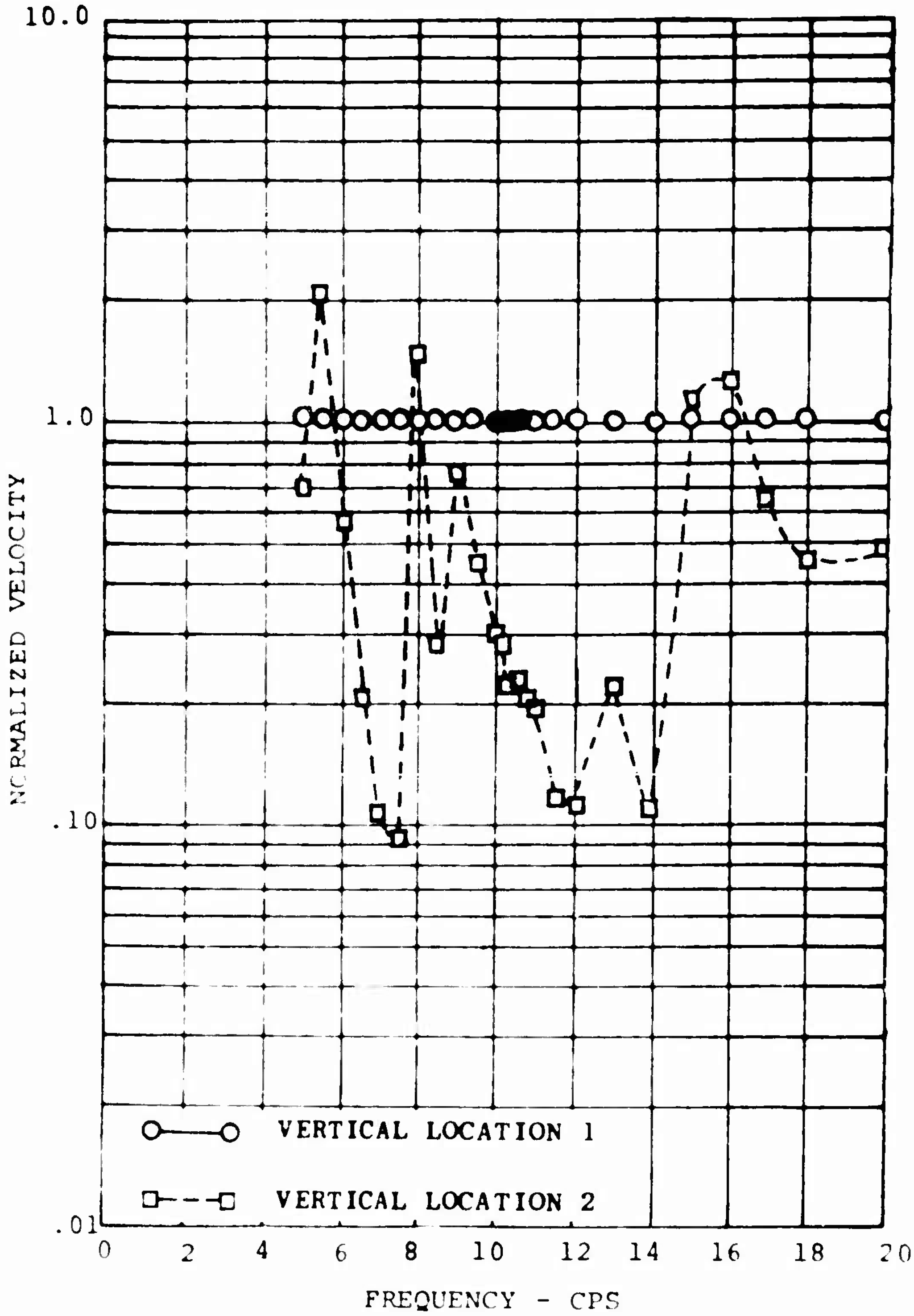


Figure 32. Normalized Vertical Velocity Input of the 160-Pound Three-Dimensional DAVI Platform for a Non-Orthogonal Excitation.

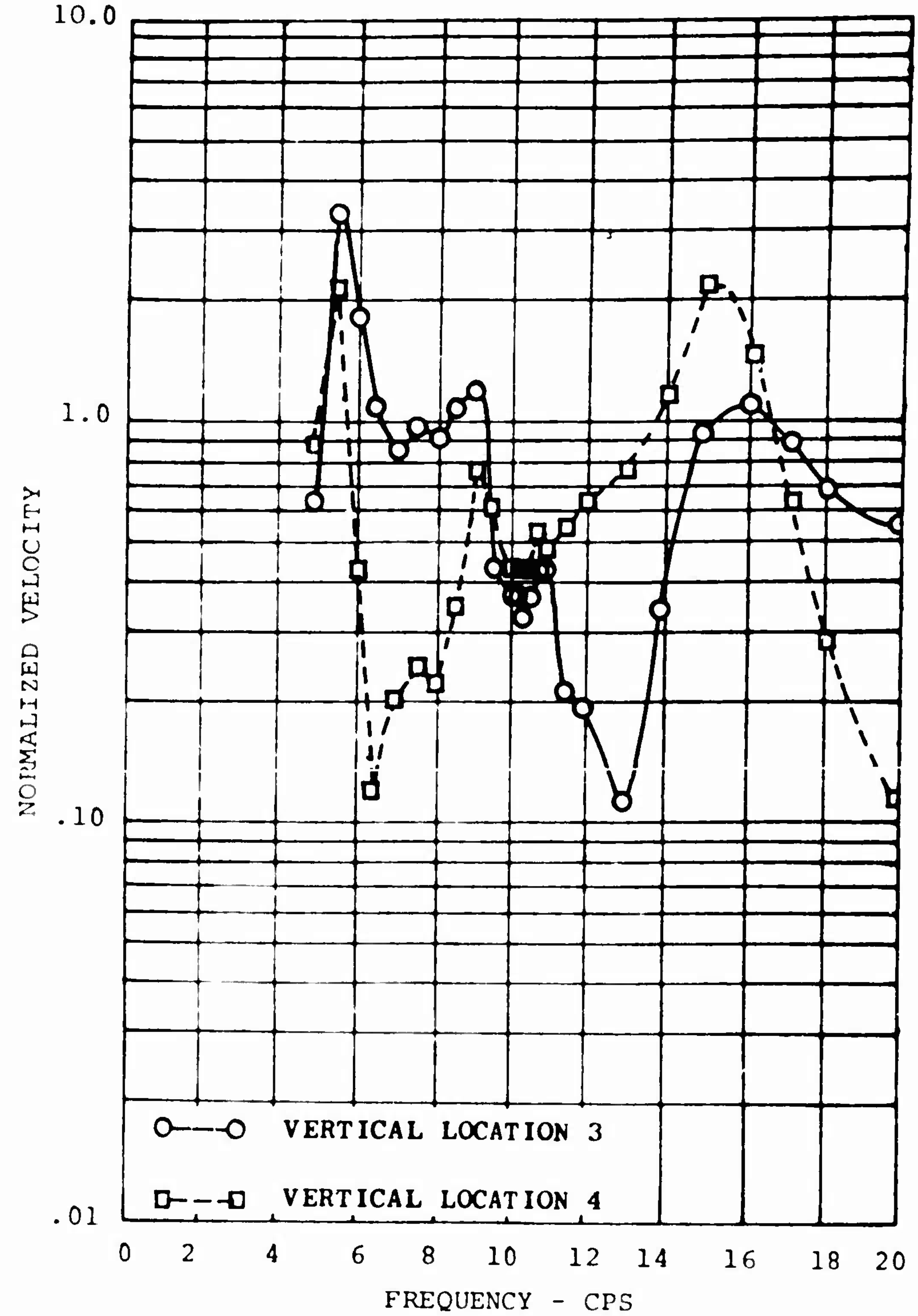


Figure 33. Normalized Vertical Velocity Input of the 160 Pound Three-Dimensional DAVI Platform for a Non-Orthogonal Excitation.

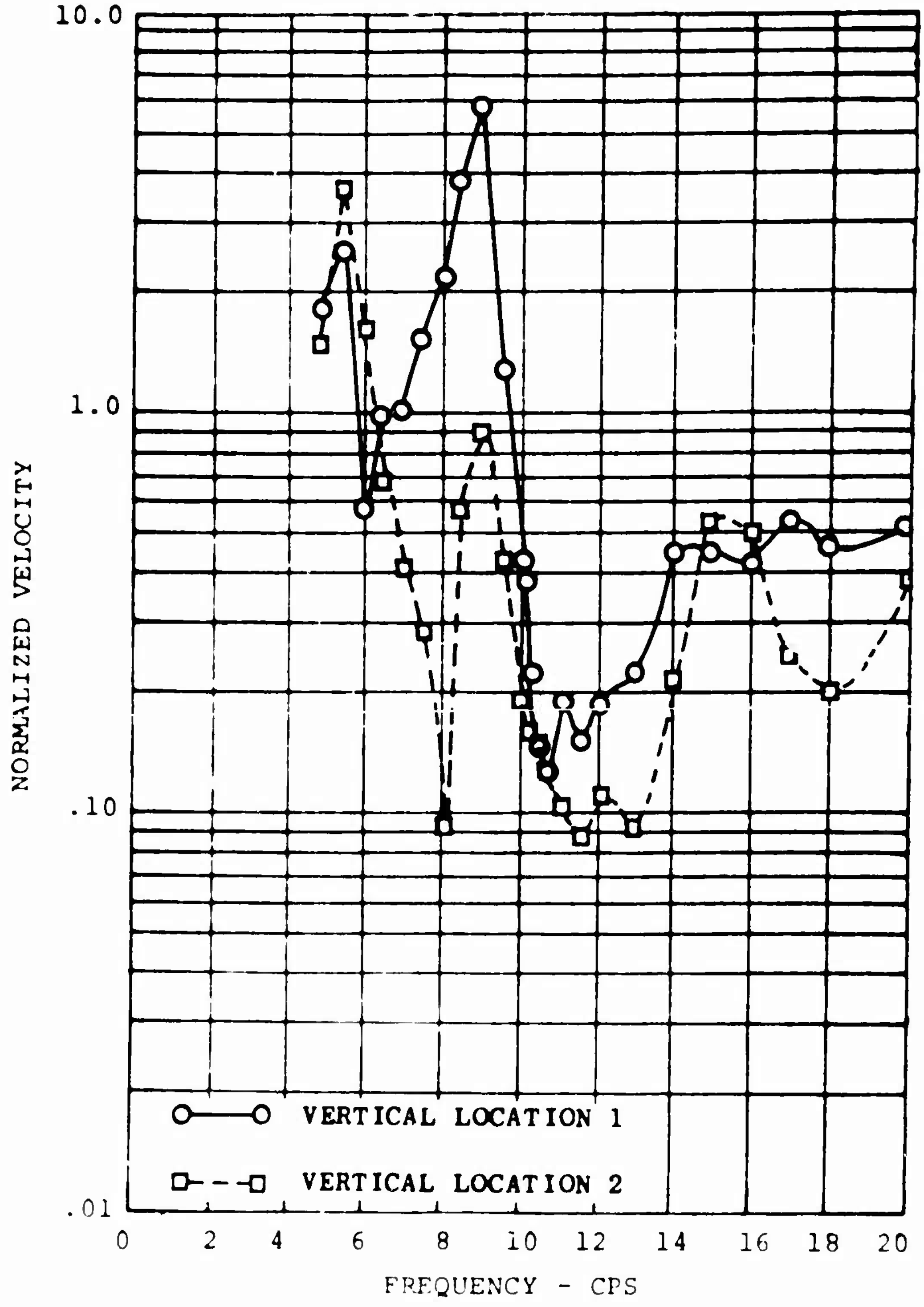


Figure 34. Normalized Vertical Velocity Output of the 160-Pound Three-Dimensional DAVI Platform for a Non-Orthogonal Excitation.

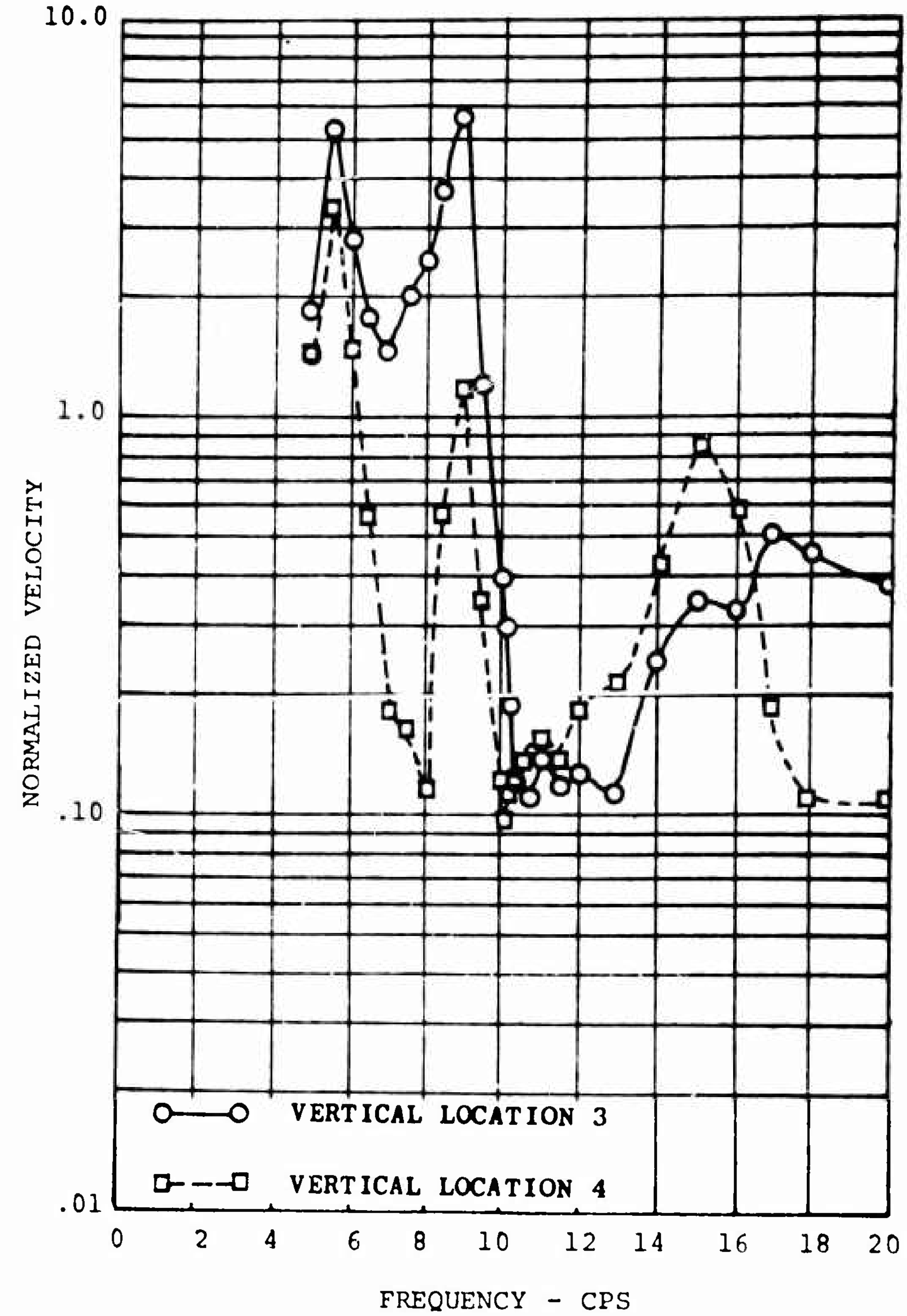


Figure 35. Normalized Vertical Velocity Output of the 160-Pound Three-Dimensional DAVI Platform for a Non-Orthogonal Excitation.

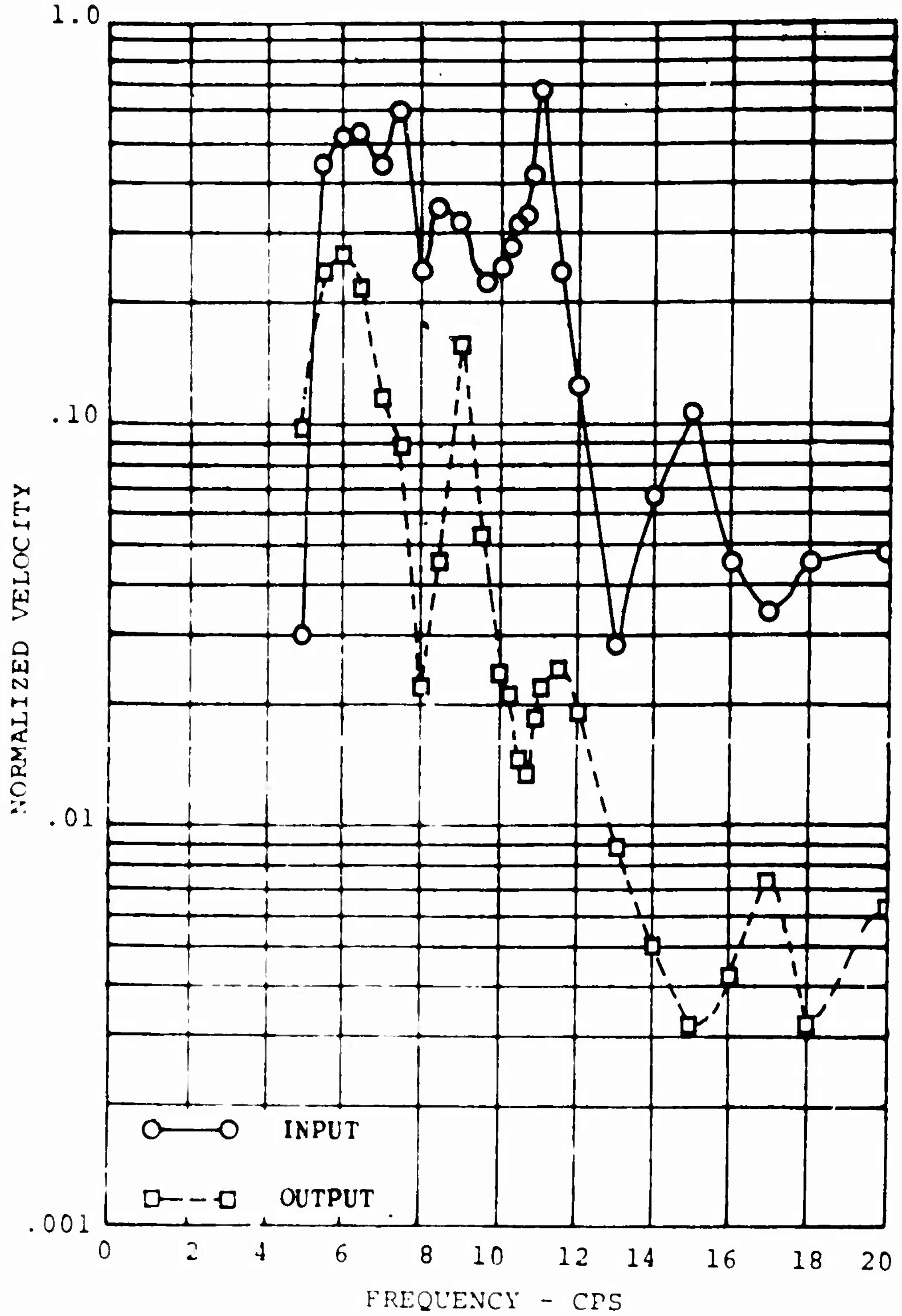


Figure 36. Normalized Longitudinal Velocity of the 160-Pound Three-Dimensional DAVI Platform for a Non-Orthogonal Excitation.

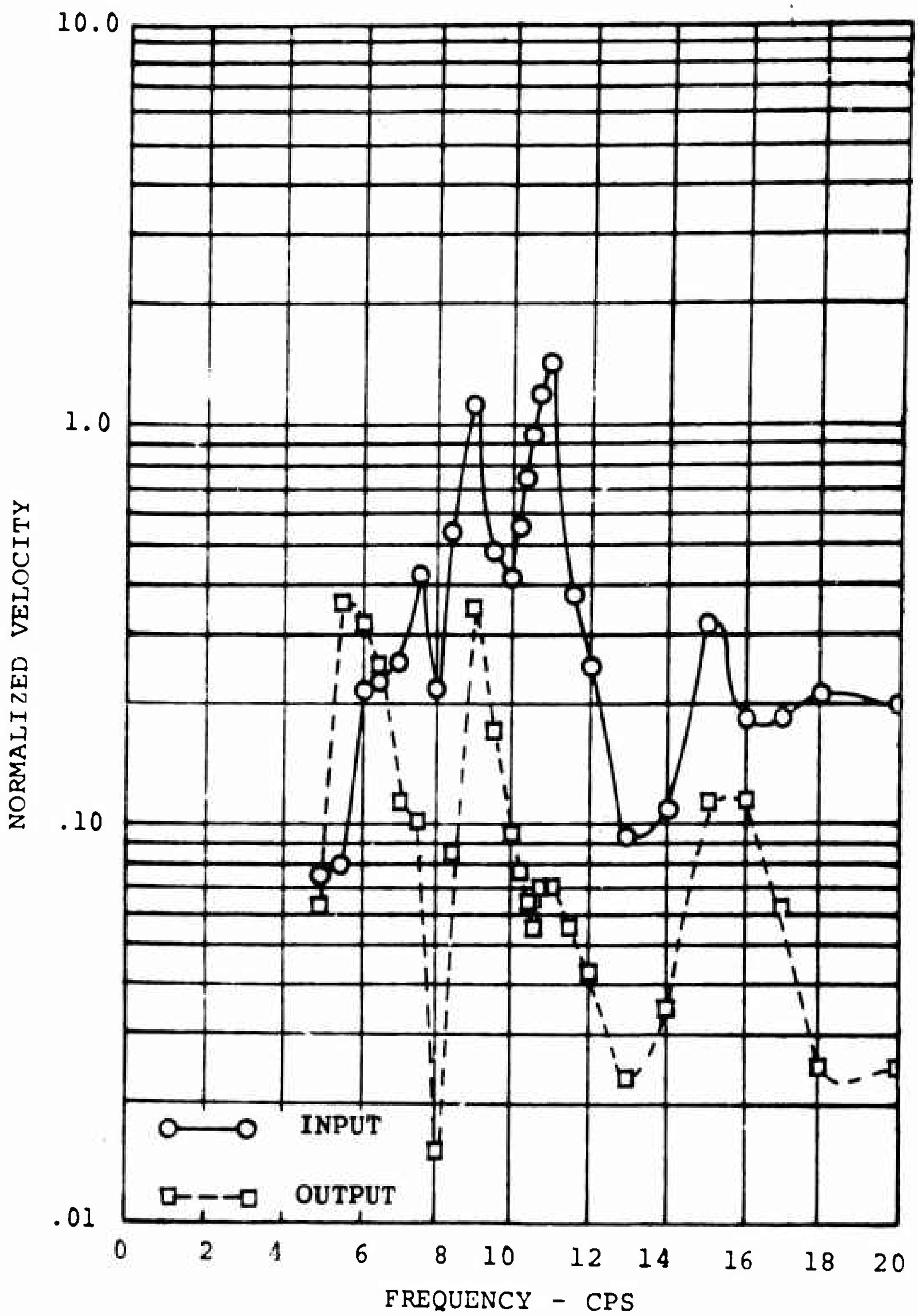


Figure 37. Normalized Lateral Velocity of the 160-Pound Three-Dimensional DAVI Platform for a Non-Orthogonal Excitation.

CONCLUSIONS

1. An antiresonance can be obtained for excitation along each of the principal axes of the preliminary three-dimensional DAVI model.

2. The offset of the isolated pivot from the elastic axis of the springs causes the translational and pitching or rolling antiresonances to differ.

3. An antiresonance can be obtained for excitation along each of the principal axes of the improved three-dimensional DAVI model.

4. The weight of the isolated platform does not affect the antiresonance of the improved three-dimensional DAVI model.

5. Isolation can be obtained utilizing the three-dimensional DAVI in all three translational directions and in pitch and roll for a non-orthogonal direction of excitation.

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13. ABSTRACT

This report contains the results of the experimental testing of the three-dimensional Dynamic Antiresonant Vibration Isolator (DAVI).

A preliminary three-dimensional DAVI model was tested on the contractor's "Zero-Friction" test rig. This test consisted of an isolation survey from 5 cps to 20 cps with the vibratory excitation applied independently in the three orthogonal axes. The results of the test showed that the three-dimensional DAVI model exhibited the characteristic DAVI transmissibility versus frequency curve along each of its principal axes.

An improved three-dimensional DAVI model was designed and four models were fabricated. These models were installed on a platform and tested for an isolated platform weight of 60 and 160 pounds and for four different directions of excitation. The results of these tests showed that excellent isolation was obtained at the tuned frequency of the DAVI for all four directions of excitation.

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Vibration Isolator						
Passive Isolator						
Antiresonant Isolator						
Low Frequency/Stiff Isolator						
Discrete Frequency Isolator						
DAVI						
Three-Dimensional DAVI						